U.S. Department
of Transportation
**Federal Transit
Administration**

Revised Measures for Assessing Major Investments:

A Discussion Draft

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An FTA Policy Paper

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Introduction and Executive Summary

PURPOSE AND OVERVIEW

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) made substantial changes to the criteria, included in the Federal Transit (FT) Act, which the Federal Government is to use to make discretionary grants to support major transit capital investment projects ("new starts"). In addition, on January 26, 1994, President Clinton issued Executive Order 12893 describing Principles for Federal Infrastructure Investments which applies to all programs. These actions require revision to FTA's Major Investments Policy.

This paper presents the Federal Transit Administration's (FTA) proposal to address the expanded criteria and Executive Order in the Major Investments Policy. While the new policy will have an impact on the local planning procedures required for federally assisted metropolitan area transportation investments, its primary purpose is to address FTA's appraisal of candidate projects for Section 3 New Starts funds. This is because the new Policy will be used to determine FTA's rating of projects in the Section 3(j) Report to Congress on recommendations for use of Section 3 New Starts funds. The paper is being circulated among interested parties for comments and suggestions.

THE LEGAL MANDATE

Section 3(i) of the FT Act provides the criteria for Federal support for new starts under Section 3. This section, which was originally added to the FT Act by the Surface Transportation and Uniform Relocation Assistance Act of 1987 (STURAA), was substantially amended by ISTEA. Specifically, the original requirement in Section 3(i)(1) that a project be "cost-effective" was expanded by the requirement that the project be "justified, based on a comprehensive review of its mobility improvements, environmental benefits, cost-effectiveness, and operating efficiencies." In addition, the FT Act now also includes certain "considerations" in Section 3(i)(2) and "guidelines" in Section 3(i)(3) to be taken into account in determining how well the project meets the criteria set forth in Section 3(i)(1).

In addition, ISTEA modified the requirements for metropolitan and statewide transportation planning. These changes were then reflected in the modifications to the joint Federal Highway Administration (FHWA)/FTA planning regulations made on October 28, 1993. The most significant change in the context of this paper is the requirement that all major **transit and highway capacity expansions** be subjected to a Major Investment Study before a specific major investment project is included in local transportation plans or Transportation Improvement Programs. This change integrates the requirement for an alternatives analysis of major transit investments contained in Section 3(i) into the ongoing transportation planning process. In addition, it requires that many Major Investment Studies will be conducted on a multimodal basis.

THE EXECUTIVE ORDER

Executive Order 12893, signed by President Clinton on January 26, 1994, describes the principles which Federal agencies are to apply in determining how to invest in all forms of infrastructure, including transportation. The Order requires a systematic analysis of the costs and benefits of proposed investments, and sets out the parameters for such analysis. The Order calls for efficient management of infrastructure, including a focus on the operation and maintenance of facilities, as well as the use of pricing to manage demand. Private sector participation in investment and management of infrastructure is encouraged. Federal agencies are also to encourage State and local governments to implement planning and management approaches which support these principles. The Executive Order calls for comparison of a comprehensive set of options and consideration of quantifiable and qualitative measures of benefits for all programs.

OBJECTIVES FOR APPRAISAL MEASURES

As FTA develops new criteria and procedures for appraising candidate new start projects, responsive to the ISTEA mandate, several objectives must be considered. These various objectives are to some extent incompatible or contradictory, implying that tradeoffs and compromises will be necessary. In sum, FTA believes that its appraisal procedures should seek to be *comprehensive*, *effective*, *efficient*, *objective*, and *comprehensible*.

The key issue in deciding on an appraisal approach is balancing "comprehensiveness" and "simplicity." Approaches range from full *Social Cost Benefit Analysis (SCBA)* through *scoring methods* in which projects are rated against a set of criteria, scores for each are assigned, weights for each are established, and composite scores calculated. A third approach is a *multiple measure method* in which projects are evaluated against several criteria, results are displayed, but no effort is made to develop a single composite score. Each of these approaches has its advantages and disadvantages, explored fully in Chapter 2.

OVERALL APPRAISAL STRATEGY

FTA intends to use a strategy based on the concepts of SCBA, but which uses a multiple measure method to evaluate the costs and benefits identified. In this way, the merits of each candidate project can be weighed explicitly against the full range of criteria called out in ISTEA. In addition, both market and nonmarket benefits will be weighed equally. All of the four major elements mentioned in ISTEA--mobility improvements, cost-effectiveness, operating efficiencies, and environmental benefits--will be fully considered. In addition, the approach takes into account the "considerations" included in Section 3(i)(2), particularly land use policies and patterns.

RECOMMENDED APPRAISAL MEASURES

Based on a detailed review of a wide range of candidate measures, described in the Appendix, FTA plans to use the following measures as a means of assessing how well candidate New Starts projects are "justified":

* **For "cost-effectiveness"**

  - the *total incremental cost per incremental transit*[1] [2] *passenger-trip* (or possibly, per incremental passenger-mile in certain cases), where the projected streams of capital and net operating costs and passenger-trips have been (in the case of the costs) expressed in constant dollar terms, and (in all cases) both cost and ridership have been discounted at the social discount rate, compared to the Transportation System Management (TSM) alternative[3].

* **For "mobility improvements"**

  - the projected aggregate *value of travel time savings* per year (forecast year) anticipated from the new investment compared to the TSM alternative. This aggregate includes the travel time impacts on people using competitive modes, along with those on the trips made by transit (both new and former transit riders). It is a *net* figure in the sense that travel time increases should be explicitly considered and used to offset the time savings of those people who experience savings. It will be expressed in absolute and regional percentage change terms. It will be valued using a set percentage of the average wage rate in the urbanized area.

  - the absolute number of *zero-car households* (or alternatively, the people resident in those households) located within ½ mile of boarding points for the proposed system increment, compared to the TSM alternative.

* **For "operating efficiencies"**

  - the forecast *change*[2] *in operating cost per vehicle service-hour* (or service-mile), for that part of the system that will be directly affected by the proposed new investment, expressed in absolute and regional percentage change terms, compared to the TSM alternative.

  - the forecast *change*[2] *in passengers per vehicle service-hour* (or service-mile), calculated on the same basis, also expressed in absolute and regional percentage change terms, compared to the TSM alternative.

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[1] If the project goals include the promotion of ridesharing in private vehicles, the trips to be forecast would be the change in *all* HOV trips (both auto and transit).

[2] That is, the difference between the forecasts for the selected alternative and for the baseline condition

[3] The Transportation System Management (TSM) alternative is defined as a low-capital investment alternative which seeks to maximize the efficiency of the existing transportation system through operational improvements and other changes in service which can be accomplished without large expenditures of capital.

- the forecast *change*[2] *in passenger miles per vehicle service-hour* (or service-mile), calculated on the same basis, also expressed in absolute and regional percentage change terms, compared to the TSM alternative.

* **For "environmental benefits"**

  - the *value of the forecast change*[2] *in criteria pollutant*[4] *emissions and in greenhouse gas emissions*, ascribable to the proposed new investment, discounted and levelized, expressed in absolute and regional percentage change terms, compared to the TSM alternative. The value of the emissions will be calculated based on standardized assumptions about the unit value of each emission.

  - the forecast *change*[2] *in the consumption of fuels of different types*, ascribable to the proposed new investment, discounted and levelized, expressed in absolute and regional percentage change terms, compared to the TSM alternative.

* **For "transit supportive existing land use policies and future patterns"**

  - the degree to which local land use policies are likely to foster transit supportive land use, measured in terms of the kinds of policies in place, and the commitment to these policies.

This set of indicators addresses the most significant issues related to project justification identified in the revised language of Section 3(i). FTA intends to continue using the present approach to assess local financial commitment issues (as required by Section 3(i)(1)(c)). In addition, the proposed set of indicators provides for an assessment which fully considers major benefits, including those which cannot easily be quantified or monetized. Moreover, while there are some obvious interrelationships among the indices, "double-counting" is minimized by keeping them relatively independent.

In particular, it should be noted that a different approach to measuring "cost-effectiveness" considerations is being proposed than that previously used by FTA. The former *incremental cost per new transit ride* measure attempted to internalize mobility effects by using monetized time savings as an offset to costs. The threshold values specified for the statistic implicitly made generous allowance for the inclusion of environmental and safety issues on a comparable basis. For the new measure, it is intended that "costs" be construed more narrowly, to comprise only the monetary value of construction, operations, and maintenance. This is because the mobility and environmental considerations are now addressed explicitly by other recommended measures.

Another major difference in the proposed new cost-effectiveness measure is that it includes annualized, levelized costs and ridership differences calculated over the analysis period, rather than costs and ridership differences calculated based on a single forecast year. While past practice has included estimates of costs on a year-by-year basis over the analysis period, accurate assessment of the ridership impacts could involve multiple ridership forecast (say for the year of

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[4] "Criteria pollutants" are those air pollutants for which specific standards have been set under the Clean Air Act Amendments, such as Carbon Monoxide, etc. It is suggested that a separate measure be computed for each major type of emission for which the subject city is in nonattainment status.

opening, the forecast year, and the year at the end of the analysis period). On the other hand, it may be possible to synthesize forecasts of the year of opening and year at the end of the forecast period using forecast year results and well known factors relating typical trends in ridership for new transit investments. FTA is interested in obtaining views on how much additional effort would be required to calculate estimated ridership impacts for multiple forecast years. FTA is also interested in views on how much accuracy would be gained by such multiple forecasts, compared with reliance on synthesized forecasts based on typical trends in ridership growth.

It should also be noted that the approach for valuing travel time savings will be changed from past practice. In the past, FTA specified use of $4.80 per hour of travel time savings and $2.40 per hour of travel time savings for non-work trip, for use in calculating the offset to costs. This value was based on the a factor of 40 percent of the national average wage rate for work travel, and one-half this amount for non-work travel. Recent analysis of the valuation of time in other programs of the Department of Transportation and elsewhere in government suggests that this value is inconsistent with these other practices. For example, analysis of models used by the Federal Highway Administration indicates use of a much higher factor of wage rates for travel time savings. Accordingly, FTA is participating with other elements of the Department to develop consistent approaches for valuing travel time savings. In the interim, FTA expects to use a factor of 80 percent of the local wage rate for calculating the value of travel time savings.

Similarly, in the past FTA did not attempt to value the environmental benefits of transit investments. The benefits of emission reductions can take a variety of forms, such as improved visibility, crop yields, and public health. The Environmental Protection Agency (EPA) is currently developing, pursuant to Section 812 of the Clean Air Act, standard monetary values of such benefits. The results of this analysis are expected to be available in 1995, and may be useful in evaluating the environmental benefits of transit.

Absent standard values of the benefits from emission reductions, avoided cost is an inferior, but potentially useful approach. The avoided cost approach, which generally is only applicable to nonattainment and maintenance areas, uses standard unit costs of pursuing alternative means of achieving emission reductions as a proxy for the benefits of such emission reductions. Some EPA analyses have, in the past, used the avoided cost approach.

Pending further analysis by EPA and additional work by FTA with other agencies within and outside the Department of Transportation, FTA intends to use values based on avoided cost as an interim proxy for the benefits of emission reductions in the relevant nonattainment/maintenance areas.

The standard unit values proposed in this document are based on nationwide averages and, therefore, do not reflect the fact that the cost of achieving emission reductions by alternative means varies depending on project location. If the environmental impacts of a proposed transit project are significant, additional analysis to develop an avoided cost relevant to that specific nonattainment/maintenance area would be appropriate.

The set of measures recommended has been selected to be mindful of the need for multimodal project appraisal measures. While the measures included in FTA's new Major Investment Policy will be used primarily to inform FTA decisions about project ratings in the Section 3(j) Report, an

effort has been made to make some of the measures applicable at the local level when multimodal studies are conducted.

Examination of nine prototypical Alternatives Analysis/Draft Environmental Impact Study (AA/DEIS), described in the Appendix (listed on pages 17 and 18) suggests that these new indices should be calculable in the major investment study phase of planning without significant extra work on the part of local project sponsors.

FTA intends these measures to apply to projects which have not yet completed the Alternatives Analysis process. Projects which are now in Preliminary Engineering would not be required to do the additional analysis. These projects would be evaluated based on existing data.

FUTURE IMPROVEMENTS

As noted earlier, SCBA forms a useful tool for analyzing the worthiness of public investments. However, the key to successful SCBA is the proper accounting for and monetizing of the full range of the benefits of a proposed investment. It is FTA's belief that while it is possible to quantify and monetize many of the benefits of transit investments, as evidenced by the approach being proposed here, ascribing a monetary value to many of the benefits is particularly difficult. This is particularly true in the absence of Government-wide standard values for some of the benefits which may be ascribed to transit projects. In addition, there is an absence of general agreement on even the valuation of certain other benefits, such as those related to the land use effects of transit investments.

This lack of Government-wide standard values or generally agreed valuation is the key reason why FTA is unable to use SCBA as the sole recommended approach at this time. FTA intends to conduct research into the valuation and monetization of the benefits of transit investments in order to develop an accepted approach. As this research proceeds, FTA intends to apply it to the quantified benefits of the investments being considered, in order to move closer to a complete SCBA approach. This research should permit FTA to begin to construct partial indices of costs and benefits as part of its evaluation of project worthiness. With time, more complete indices can be constructed, ultimately resulting in a full-fledged SCBA approach.

SPECIFIC COMMENTS REQUESTED

In providing comments on this document, FTA asks that the following questions be specifically addressed in replies:

1. Are there other ways FTA could manage the "New Starts" program and still comply with statute (e.g., industry standards and measurements which FTA accepts and utilizes for the Section 3(j) Report)?

2. What are the key issues in monetizing transit's benefits? What information is now available? What are the most fruitful areas for research?

3. What approaches are available for valuing travel time savings? How should the value of travel time savings be set? Is a value based on average wage rates appropriate? Is 80 percent appropriate? Is it appropriate to use different values by trip purpose? By mode? By type of time saved (e.g. wait time versus in-vehicle time?

4. What approaches are available for valuing emission reductions? How should the values of unit emission reductions be set? Are the values suggested by EPA based on cost-avoidance appropriate?

5. Is the overall appraisal strategy (i.e., use of the multiple measure method) appropriate? Can the use of this strategy be made workable without explicitly specifying how FTA will tradeoff between the criteria? Should FTA, instead, specify that it will explicitly weight one or more of the criteria more heavily? If so, which one(s), why and how?

6. Are the particular measures proposed for each of the ISTEA justification criteria appropriate?

   - Do the proposed measures adequately represent the criteria called out in Section 3(i)?

   - Are the proposed measures workable? Can data be developed for the measures as part of the normal process of evaluating major investments?

   - Are the measures likely to be able to distinguish between projects of varying merit?

7. How can FTA assure the quality of the data submitted in support of proposed projects in terms of the measures proposed when Major Investment Analyses are to be conducted as part of the Metropolitan Planning Process, as called for in the Final Rule on planning, issued October 28, 1993? How can FTA assure consistency among cities in terms of modeling input assumptions (e.g., gasoline prices, inflation rates, or modeling methods)? Must it?

8. Is this approach sufficiently quantifiable to allow for the Secretarial findings and determinations for funding required by the Federal Transit Act, and for FTA ranking among candidate projects?

9. How much additional effort is involved in calculating the proposed annualized, levelized cost-effectiveness index using multiple forecasts of ridership impacts? How many different year forecasts are needed to accurately portray the stream of ridership impact benefits? Which years are most appropriate to forecast (year of opening, forecast year, last year of analysis period, other years)? How much additional accuracy is gained compared to synthesizing the stream of ridership impacts using a single forecast year and known trends in ridership growth for new investments?

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The Context for This Document

OVERVIEW

Revisions made by the ISTEA to the FT Act changed the criteria by which the Federal Government is to make discretionary grants, under Section 3 of the Act, to support major transit capital investment projects ("new starts"). In addition, they also changed the requirements for transportation planning. On January 26, 1994, President Clinton signed Executive Order 12893 setting forth Principles for Federal Infrastructure Investments. This Chapter describes these actions, summarizes the existing Major Investments Policy and how it evolved, and describes recent work by FTA on alternative approaches to how major investments could be assessed. It is intended to provide background information discussions about modifications to FTA's Major Investment Policy to address the changes made by ISTEA and the Executive Order.

THE LEGAL MANDATE

Section 3(i) of the Federal Transit Act provides the criteria for Federal support through discretionary grants under Section 3 of the Act for new starts. Section 3(i), which was originally added to the FT Act by the Surface Transportation and Uniform Relocation Assistance Act of 1987 (STURAA), was substantially amended by the ISTEA. The law now includes the following relevant provisions:[5]

Section 3(i)(1)
A grant or loan for construction of a new fixed guideway system or extension of any fixed guideway system may not be made under this section unless the Secretary determines that the proposed project is

* based on the results of an alternatives analysis and preliminary engineering;
* *justified based on a comprehensive review of its mobility improvements, environmental benefits, cost-effectiveness, and operating efficiencies;* and
* supported by an acceptable degree of local financial commitment, including evidence of stable and dependable funding sources to construct, maintain, and operate the system or extension.

Section 3(i)(2)
In making determinations under this subsection, the Secretary shall

* *consider the direct and indirect costs of relevant alternatives*;

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[5] Substantive changes introduced by ISTEA related to project justification are shown in italics.

* *account for costs related to such factors as congestion relief, improved mobility, air pollution, noise pollution, congestion, energy consumption, and all associated ancillary and mitigation costs necessary to implement each alternative analyzed; and*

* *shall identify and consider transit supportive existing land use policies and future patterns, and consider other factors including the degree to which the project increases the mobility of the transit dependent population or promotes economic development, and other factors that the Secretary deems appropriate to carry out the purposes of this Act.*

Section 3(i)(3)
The Secretary shall issue guidelines that set forth the means by which the Secretary shall evaluate results of alternatives analysis, project justification, and the degree of local financial commitment for the purposes of paragraph (1).

Project justification criteria shall be adjusted to reflect differences in local land costs, construction costs, and operating costs.

Section 3(i)(5)
A new fixed guideway system or extension shall not be subject to the requirements of this subsection and the simultaneous evaluation of such projects in more than one corridor in a metropolitan area shall not be limited if

* *the project is located within an extreme or severe nonattainment area and is a transportation control measure, as defined by the Clean Air Act, that is required to carry out an approved State Implementation Plan; or*

* *assistance provided under this section accounts for less than $25 million, or less than one third of the total cost of the project or an appropriate program of projects as determined by the Secretary.*

ISTEA PLANNING REQUIREMENTS

On October 28, 1993, FTA and the Federal Highway Administration (FHWA) jointly issued new regulations (23 CFR Part 450 and 49 CFR Part 613) implementing the changes made to the Federal Transit Act and Title 23, USC, by ISTEA with regard to the requirements for metropolitan and statewide transportation planning. The most important change, for the purposes of this paper, is the addition of a requirement for studies of major metropolitan transportation investments, both highways and transit, as a part of the metropolitan transportation planning process. In part, this requirement was added to respond to Section 3012 of ISTEA which required FTA to conform its environmental review requirements with those of FHWA. More importantly, it was designed to integrate the long-standing requirement in Section 3(i) for an analysis of alternatives into the metropolitan transportation planning process to allow for the appropriate consideration of how flexible funds would best be spent to promote multimodal planning. Specifically, 23 CFR Section 450.318 states the following:

> "(a) Where the need for a major metropolitan transportation investment is identified, and Federal funds are potentially involved, major investment (corridor and subarea) studies shall be undertaken to develop or refine the plan and lead to decisions by the MPO, in cooperation with participating agencies, on the design concept and scope of the investment. . .

"(c) . . . major investment studies shall evaluate the effectiveness and cost-effectiveness of altemative investments or strategies in attaining local, State, and national goals and objectives. The analysis shall consider the direct and indirect costs of reasonable alternatives and such factors as mobility improvements; social, economic, and environmental effects; safety; operating efficiencies; land use and economic development; financing; and energy consumption.

"(d) These major investment studies will serve as the "altematives analyses" required by Section 3(i)(1)(A) of the Federal Transit Act for certain projects for which discretionary Section 3 'New Start' funding is being sought. The studies will also be used as the primary source of information for other Section 3(i)(1)(A) Secretarial findings on cost-effectiveness, local financial commitment and capacity, mobility improvements, environmental benefits, operating efficiency, etc."

These studies must be completed before a local policy decision is made to include a major investment project in local long range transportation plans and Transportation Improvement Programs. In addition, these studies will also form the basis for assessment of project worthiness, required by Section 3(i)(1) and Executive Order 12893. The studies required by these regulations will develop the information to be used by FTA to make these determinations.

EXECUTIVE ORDER 12893

Executive Order 12893, issued January 26, 1994, sets forth principles for Federal Infrastructure Investments. The order requires all Federal agencies with infrastructure responsibilities to implement the following principles in management of their programs:

(a) *Systematic Analysis of Expected Benefits and Costs.* Infrastructure investments shall be based on systematic analysis of expected benefits and costs, including both quantitative and qualitative measures, in accordance with the following:

(1) Benefits and costs should be quantified and monetized to the maximum extent practicable. All types of benefits and costs, both market and nonmarket, should be considered. To the extent that environmental and other nonmarket benefits and costs can be quantified, they shall be given the same weight as quantifiable market benefits and costs.

(2) Benefits and costs should be measured and appropriately discounted over the full life cycle of each project. Such analysis will enable informed tradeoffs among capital outlays, operating and maintenance costs, and nonmonetary costs borne by the public.

(3) When the amount and timing of important benefits and costs are uncertain, analyses shall recognize the uncertainty and address it through appropriate quantitative and qualitative assessments.

(4) Analyses shall compare a comprehensive set of options that include, among other things, managing demand, repairing facilities, and expanding facilities.

(5) Analyses should consider not only quantifiable measures of benefits and costs, but also qualitative measures reflecting values that are not readily quantified.

(b) *Efficient Management.* Infrastructure shall be managed efficiently in accordance with the following:

(1) The efficient use of infrastructure depends not only on physical design features, but also on operational practices. To improve these practices, agencies should conduct periodic reviews of the operation and maintenance of these facilities.

(2) Agencies should use these reviews to consider a variety of management practices that can improve the return from infrastructure investments. Examples include contracting practices that reward quality and innovation, and design standards that incorporate new technologies and construction techniques.

(3) Agencies also should use these reviews to identify the demand for different levels of infrastructure services. Since efficient levels of service can often be best achieved through properly pricing infrastructure, the Federal Government -- through its direct investments, grants, and regulations -- should promote consideration of market-based mechanisms for managing infrastructure.

(c) *Private Sector Participation.* Agencies shall seek private sector participation in infrastructure investment and management. Innovative public-private initiatives can bring about greater private sector participation in the ownership, financing, construction, and operation of infrastructure programs referred to in Section 1 of this Order. Consistent with the public interest, agencies should work with State and local entities to minimize legal and regulatory barriers to private participation in the provision of infrastructure facilities and services.

(d) *Encouragement of More Effective State and Local Programs.* To promote the efficient use of Federal infrastructure funds, agencies should encourage the State and local recipients of Federal grants to implement planning and information management systems that support the principles set forth in Section 2(a) through (c) of this Order. In turn, the Federal Government should use the information form the State and local recipients' management systems to conduct the system-level reviews of the Federal Government's infrastructure programs that are required by this Order.

A SYNOPSIS OF RELEVANT PREVIOUS PRACTICE

In the version of Section 3(i) originally introduced into the FT Act in 1987, the criteria for Section 3 new start funding were much less extensive than under ISTEA, but in some ways more stringent. The second criterion of what is now subsection 3(i)(1) required that the proposed project be "cost-effective" under guidelines to be issued by the Secretary. The language also empowered the Secretary to consider "such other factors as the Secretary deems appropriate."

Prior to the introduction of Section 3(i), FTA[6] issued a *Statement of Policy on Major Urban Mass Transportation Investments.*[7] This document identified the "incremental cost per new transit trip" as FTA's primary index of the cost-effectiveness of a proposed major capital

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[6] Then the Urban Mass Transportation Administration (UMTA).

[7] *Federal Register* (49 FR 21284), May 18, 1984.

investment project. This index was computed by dividing a measure of the net incremental costs of the project by the forecast incremental transit ridership from the project, compared to the Transportation System Management (TSM) alternative. The numerator comprised the annualized capital and operating costs projected for the project, offset by an estimate of the monetary value of aggregate travel time savings for existing riders.

Also in 1984, FTA established threshold values of the cost-per-new-trip index that would need to be met for a proposed project to continue to receive Federal financial support through the various stages of the Federally-mandated planning process. To progress from the "system planning" phase to the "alternatives analysis" phase, the preliminary estimate of the cost per new trip should not exceed $10; to move from alternatives analysis to "preliminary engineering," the estimated cost per new trip should not exceed $6.

The latter threshold was based on the following logic. An FTA study in 1984 estimated that the national average "new" transit trip would produce about $2.80 in direct benefits to *new users* of the system, based on liberal estimates of the potential savings in parking costs, travel time, and private vehicle operating costs in a prototypical setting. Indirect benefits to nonusers -- from such impacts as air quality and urban form effects -- were more difficult to quantify, but were argued to be broadly proportional to the magnitude of the mode share effects. An investment that produces minimal ridership impacts cannot be expected to have other than minimal indirect benefits. Even the most liberal attempts to quantify indirect benefits would not set them as *greater than* the direct benefits to users, in total. Hence, it was argued, a $6 per new trip threshold value -- double the $2.80 figure, rounded to the next highest dollar -- would serve to eliminate those projects that appeared to have minimal possibility of being cost-effective, while including projects that may, on further planning and analysis, prove to be of questionable merit.

Following the 1987 addition of Section 3(i) to FT Act, which for the first time specified *cost-effectiveness* as a major statutory criterion for Federal new start funding, FTA issued a notice of proposed rulemaking[8] to implement Section 3(i). This proposed that the threshold test for the incremental cost per new transit trip should remain the primary criterion for assessing project cost-effectiveness. In addition, the NPRM proposed that a second, alternative threshold could be applied to project proposals, a "user benefit index."

The user benefit index was developed by FTA to address various public comments regarding the 1984 policy statement and to overcome some computational problems encountered in using the cost-per-new-trip measure. It is computed by dividing the annualized incremental capital and operating costs of the project by an estimate of the annual incremental user benefits, expressed in equivalent hours of travel time savings.[9] The NPRM set a threshold maximum cost of $8 per hour of user benefit as the criterion for progression from alternatives analysis to preliminary engineering, based on a national average value of travel time using 40 percent of the wage rate as the basis for setting this value. It was intended that future projects would be required to pass either the new trip index or the user benefit index thresholds before the Federal Government would fund the preliminary engineering phase.

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[8] *Federal Register* (54 FR 17878), April 25, 1989. This document includes an expanded history of the evolution of Federal decisionmaking in the allocation of Section 3 funding.

[9] The estimate of the user benefits, based on the economist's concept of "consumers' surplus," accounts both for the change in the number of the trips and the travel time savings.

RECENT FTA WORK ON THE APPRAISAL OF NEW STARTS

Final rulemaking on these matters was delayed in response to specific congressional guidance, pending the development of what subsequently became the ISTEA legislation. In the meantime, FTA has continued to refine the computation and interpretation of the cost-effectiveness measures set out in the 1989 NPRM. This work has included:

* updated quantifications of such effects as traffic congestion reduction, noise reduction, improved air quality, fewer accidents, and reduced subsidization of commutation;

* exploration of the impact of proper discounting (to take account of the different time profiles for the expenditure of costs and the accrual of benefits) on the computation and use of the cost-effectiveness indices; and

* exploration of the implications of using project-specific (rather than nationally uniform) threshold values, to reflect the heterogeneity of CBD-bound and non-CBD-bound travel, and the variation of conditions across US cities.

This work concluded that, because there is significant variation in congestion levels, parking charges, wage rates, and new system performance in US cities, using project specific threshold standards, rather than national average standards, for the "cost per new transit trip" measure would be likely to improve decisionmaking. It was recommended that more comprehensive and precise attempts be made to value the diverse benefits of new transit infrastructure. Literature review and the collection of new data suggested that if a national standard was continued in use, the uniform threshold of $6, established in 1984 as the criterion necessary to enter federally supported "preliminary engineering," remained substantially valid. Despite 25 percent general inflation between 1984 and 1990, the best estimate of an appropriate revised national threshold was a maximum of $6.16 per new transit ride, assuming use of 40 percent of the wage rate for the value of time.

Each year FTA submits to Congress a report on the level and allocation of funding to be made available under the Section 3 new start program, as required by Section 3(j) of the Act. In an attempt to broaden the information provided in a manner that was consistent with the revised allocation criteria of ISTEA, the FY 1994 and 1995 reports included *several* indices for each proposed project, where they were available. Thus, rather than relying only on a single measure, with a specific threshold, FTA now relies on a combination of a variety of factors to determine project merit:

* for **cost-effectiveness**, the "cost per new transit trip" measure;

* a rating of the level of **mobility improvement** afforded by the project, based on the projected total number of hours of travel time saved per day by the project, when compared with the baseline alternative [10,000 or more hours saved was rated "high," fewer than 10,000 hours saved was rated "medium," and projects anticipated to *increase* total travel time were rated "low"];

* for **environmental benefits**, the U.S. Environmental Protection Agency classification of the city for ozone ["extreme," "severe," "serious," "moderate," "marginal," "sub-marginal," "transitional," and "attainment"] and for carbon monoxide ["serious," "moderate," "not classified," and "attainment"], as an indication of the severity of the region's air quality problem;[10] and

* for **operating efficiencies,** the estimated reduction in systemwide operating cost per passenger, [a 5 percent or higher reduction was rated "high," a smaller reduction was rated "medium," while an increase in per passenger costs was rated "low"].

In addition, FTA has given significant weight in these reports to the readiness of projects to progress and the local financial commitment to the projects in determining which projects be recommended for funding.

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[10] These classifications do not indicate the extent to which the proposed project might *impact* local air quality but they are relevant to whether or not the project might be exempt (under Section 3(i)(5)) from justifications that would otherwise be required.

3
Considerations in Developing New FTA Project Appraisal Procedures

OBJECTIVES FOR APPRAISAL MEASURES

As FTA develops new criteria and procedures for appraising candidate new start projects, responsive to the ISTEA mandate, several objectives must be considered. These various objectives are to some extent incompatible or contradictory, implying that tradeoffs and compromises will be necessary. FTA believes that its appraisal procedures should seek to be "*comprehensive*," "*effective*," "*efficient*," "*objective*," and "*comprehensible*." The discussion will next expand upon and explain each of these terms, and the objectives that they summarize, in turn.

Comprehensiveness

The ISTEA language itself directs that FTA appraisal should involve a "comprehensive review." The aspects required specifically in the legislation for consideration in this review are:

* congestion relief (and other mobility improvements);
* mobility impacts for the transit-dependent population;
* air pollution impacts, noise pollution impacts, and other environmental effects;
* energy consumption effects;
* the ability of existing and future land use patterns to support the potential transit investment; and
* the economic development of the area served.

In addition, the Executive Order requires a systematic analysis of costs and benefits and calls for inclusion of all types of benefits and costs, both market and nonmarket. Finally, the requirement for major investment studies of both highways and transit projects suggests that measures should be applicable to multimodal studies, to the extent possible.

Effectiveness

For project appraisal criteria and procedures to be effective, they must be capable of differentiating between proposed projects in several different dimensions. First, it is important to recognize that while all costs and benefits of a project should be considered, the evaluation of them will vary with the goals and objectives of the evaluator;[11] different factors are more relevant to the Federal Government, for instance, than to the local governments involved. While the primary focus of the Federal government's project appraisal practices needs to be on Federal funding decisions, there is a good deal of overlap with local government needs; thus those practices should aim to be of value for local decisionmaking as well.

[11] This point is expanded on by (for example) Wohl and Hendrickson (1984) (Section 14-1) and Beimborn and Horowitz (1993) (page 9).

Appraisal methods should allow FTA to make valid comparisons of candidate projects *across cities*. Work already undertaken by FTA has addressed the question whether the existing indices of cost-effectiveness should be judged against threshold values that vary by city type, and the ISTEA revision of Section 3(i) requires that project justification criteria be "adjusted to reflect differences in local land costs, construction costs, and operating costs." It is reasonable to assume, for example, that a proposal that costs $15 per new rider in a city with high density, costs and levels of traffic congestion would generate a greater proportional return of net benefits than a "$5 per new ride" project in a smaller, less densely populated city because attracting a new rider in a city with higher density, costs and levels of congestion is likely to generate much more in the way of benefits..

With recent increased emphasis in Federal transportation policy on *intermodal* planning and decisionmaking, it would also be appropriate if the adopted evaluation measures and procedures allowed for various comparisons across investments in different modal technologies. In the urban transportation context, this primarily means appraising proposed major investments in the *highway* infrastructure alongside transit proposals, using comparable measures for both. Government-wide guidance on how to implement the Executive Order on infrastructure will help achieve this goal.

Efficiency

"Efficient" project appraisal has several implications. The data to be used should ideally be assembled as a normal part of the current project planning activities, and not require a significant incremental cost in gathering new data or analyzing data in costly new ways.

Equally important, the procedures and measures should focus attention quickly on those marginal projects that are close to the "yes" or "no" decision boundary for Federal funding. Local or Federal staff should not expend a lot of appraisal effort on projects that are the most obvious "winners" or "losers." Rather, the intent should be to filter down quickly, so that most attention can be directed to those projects that are in the "*questionable*" category, so defined at the lower end to give all potentially valuable projects the benefit of the doubt (as does the $6 per new trip cost-effectiveness threshold). Of course, the greater the number of justification criteria, the harder it may become to settle quickly on clear "winners" or "losers," and the greater the proportion of proposals that are in the "questionable" category.

Objectivity

While it is clear that the basis for any project justification needs to be objective -- at least to the level of broad categories -- this connotes something more. Ideally, the procedures for deriving the measures should be sufficiently well-defined, unambiguous, and objective so that there is limited scope for misrepresentation. Unfortunately, forecasting the demand for major new public transportation investments must rest on a large number of assumptions. Project appraisal measures can only be as good as the cost estimates and demand forecasts that underlie them, and while FTA may engage independent expertise to appraise the credibility of these estimates at the preliminary engineering phase, at existing staffing and funding levels it is more difficult for FTA to ensure the credibility of the estimates used in earlier planning stages. Also, although a number of

transit goals do not lend themselves to quantitative analysis (e.g., land use effects), there is still the need to ensure that evaluation criteria can consistently distinguish among alternatives competing for funds.

Comprehensibility

To be "comprehensible" by the various constituencies interested in them, FTA project appraisal methods should be simple and intuitively interpretable. Unfortunately, simplicity and comprehensiveness are likely to be mutually opposed. Comprehensiveness dictates that many factors be taken into account, while simplicity requires that these be reduced to a relatively small number of measures. Possible ways of reconciling the two objectives are addressed in the next section.

It is certainly helpful in gaining acceptance for project appraisal criteria if the indicators used can be readily interpreted in the experience of the audience. A formal economic definition of "benefits" in terms of "consumer surplus" is frequently problematic in this regard. A dollar benefit figure is always difficult to explain to a lay audience. This is in part why FTA in 1984 chose to use a "cost per new trip" measure as the index of cost-effectiveness. People have some experience of the costs of urban trips, and can interpret the resulting figure in the light of that experience. If a new trip by the proposed system is projected to cost $12 when the average (unsubsidized) taxicab fare in the city is only $5 and the operating cost per ride on the existing bus system is $1.75, it immediately raises questions about whether appropriate alternatives have been properly appraised. It also raises questions about whether the "external" benefits (in terms of air quality and other environmental effects, or urban form considerations) could credibly be sufficiently large to justify the magnitude of the difference in cost.

BALANCING "COMPREHENSIVENESS" AND "SIMPLICITY"

There is a range of different approaches to making informed, objective business or societal decisions from among mutually-exclusive alternative actions, involving the weighing of a diverse set of considerations. Cases from the ends of the spectrum and an intermediate approach can be taken as prototypical of the options available:

* The anticipated implications for each major type of impact can all be expressed in terms of a common unit of measure -- most often, dollar value -- and manipulated in various prescribed ways to develop a single index that is used to judge the relative merits of the alternative courses of action. For public sector decisions, *social cost/benefit analysis* (SCBA) follows this general approach.

* The anticipated implications for each major type of impact are forecast in a variety of different units of measure. Based on an assessment of the relative importance of the different types of impact to the decisionmaking organization, weights are assigned to the different appraisal criteria. These weights are then used to condense the various measures to a single value of "rating points." This approach can be characterized as the "*scoring method.*"

* The anticipated implications for each major type of impact are forecast in a variety of different units of measure. This information is conveyed to the decisionmaker(s) in a format designed to highlight the differences among the alternative actions and the key tradeoffs involved in choosing between them. The choice is then made, consistent with the power structure, political processes, and values of those people or organizations in a position to influence the outcome. This approach can be characterized as the "*multiple measure method.*"

Social Cost/Benefit Analysis (SCBA)

In the private sector, rational investment planning typically involves identifying which of several candidate investment opportunities will maximize the lifetime return on the investment, after making corrections for the possibility that the streams of expenditures and income may be occurring at different points in time. In the public sector, objectives are much more diverse (and often more nebulous). Further, the benefits are often difficult to value and monetize, while in the private sector, the key issue is almost always monetary, in the form of increased profit. Correspondingly, criteria for evaluating potential investments are more varied, and depend in part on the viewpoint from which the evaluation is being made.

For example, investment in a major new transit facility may return not only the revenues from its users. It could also create other benefits to society insofar as it reduces the time of some users' travel, or creates travel time savings on congested highways by diverting automobile users, or leads to improved public health through cleaner air. From the viewpoint of society at large, all of these outcomes -- "social benefits" -- are returns on the investment.

The economist's tool for appraising public works projects, from the societal viewpoint, is social cost/benefit analysis.[12] In brief, it seeks to gauge the return on public sector investments by identifying all of the social benefits likely to result, estimates their size, reduces them all to dollar value terms, and compares the total benefit to the cost, over the expected useful life of the investment. As with the private sector analogy, care has to be taken to correct for differing time profiles of the cost and benefit streams, and to remove the effects of inflation. Considerable care is also necessary to ensure that none of the benefits is counted more than once.

SCBA provides a comprehensive, rigorous approach to appraising major public sector investments. Knowing with some accuracy the total social benefits and costs of each candidate project, all in constant dollars and in present value terms, is useful in two ways. First, one can probably reject as unjustifiable any project for which the total benefits are less than the costs. An exception to this might be a case in which equity concerns constrain the application of SCBA results. Second, one can rank the projects in order of decreasing benefit/cost ratio, and program them by moving down from the top of the list (the project with the highest ratio) until the capital budget is exhausted. In that way, we would be maximizing the return of social benefits for a given total expenditure.

Nonetheless, SCBA presents several major challenges. First, it is not easy to do properly. It requires a strong causal understanding of the outcomes of the project and, particularly, of the behavior of consumers. Second, the concept that economists use to derive a measure of user

[12] Mishan (1976) provides a comprehensive textbook.

benefits -- consumer surplus, or the aggregate difference between what consumers are *willing to pay* and what they *do pay* for the service -- is sometimes difficult to understand and communicate.

Third, translating all the diverse impacts of a transit project into dollar value terms is a challenging task. Depending on the nature of the project, such impacts might be initially forecast in such heterogeneous units as years of life saved or prolonged, tons of pollutants reduced, or hours of time saved. By examining markets in which people are making relevant decisions that involve trading, for monetary differences, such aspects as varying risks of death, or the purity of air and water resources, or time savings, economists have devised ingenious econometric methods to infer the implicit monetary value of these other units.[13] However, there is often little homogeneity in the values estimated by these methods, for a variety of reasons. For example, the literature contains estimates for the value of a statistical life that vary between *zero* and *$15 million*, based on studies of how wage rates vary with the level of occupational risk.[14] In particular, there are no Government-wide standards for monetizing such values at this time. While this is not as much of a problem if SCBA is used only to rate projects within a single program, such as Transit New Starts, this lack of standardization will be problematic if an effort is made to review the results of SCBA across programs.

The discipline of thought and logic necessary in SCBA to articulate a clear accounting of the various types of benefits and costs, to measure benefits and costs relative to a clearly defined baseline situation, to focus on the true opportunity costs of the resources consumed, and to avoid double counting -- all these factors make the technique a theoretically satisfying standard for public sector project appraisal. Indeed, there is an abundant body of literature on the technique.

Economists have argued that FTA's project appraisal methods would be improved if they were to focus on net social benefits, broadly construed, in preference to "cost-effectiveness."[15] To the extent that environmental, land use, and mobility impacts of major transit investments could be credibly translated into dollar values, SCBA would offer the hope of appraising most of the Section 3(i) concerns in a single measure. Thus, the technique provides the theoretical model by which other methods of appraising transit projects can be judged. As FTA has worked to improve the basis and application of the threshold "cost per new trip" test, for example, the SCBA model has provided the basis for structuring the thinking. In addition, FTA has worked to develop better tools to compare across modes.

The practical problems summarized earlier mean that the theoretical elegance and integrity of SCBA will not guarantee uncritical acclaim for, nor even the validity of, its findings. The experience in the United Kingdom is instructive in this regard. One of the early applications of the technique was in the appraisal of a major transit investment -- London's Victoria Line[16] -- and the method has been extensively adopted in transport investment appraisals of all types in the United Kingdom. However, the difficulties in implementing the technique became widely

[13] Such techniques, when they rely on an analysis of marketplace behavior, are called "revealed preference" methods. Sometimes (less often), the values are inferred from opinion survey responses ("stated preference" evidence).

[14] See Miller (1990). Miller argues that by eliminating studies judged unreliable and adjusting other studies to reflect common assumptions, the variance in results is greatly reduced. Other specialists in the value-of-life literature disagree. See Havrilesky (1990) and Frankel and Linke (1992).

[15] See, for example, Johnston and DeLuchi (1989) and Lee (1989a).

[16] Foster and Beesley (1963).

appreciated after its extensive use in the Roskill Commission's Third London Airport Study.[17] Button (1982) reports that:

> "...despite the widespread adoption of cost-benefit analysis by the transport sector, there has been a gradual disillusionment with the all-embracing stereotype appraisal ... This has manifested itself most strongly since the rejection of the Roskill Committee's recommendation regarding the siting of a third London airport, and became particularly noticeable at public inquiries into new road proposals in the late 1970s. While the criticisms of cost-benefit analysis as a method of socially evaluating transport investments have been extensive, they are perhaps most adequately summed up by Wildavsky (1966), 'Although cost-benefit analysis presumably results in efficiency by adding the most to national income, it is shot through with political and social value choices and surrounded by uncertainties and difficulties of computation.' The Chairman of British Rail summarized the attitude evolving in the UK when he argued that there is a need for an approach that 'can be understood by ordinary intelligent people ... incorporates the methods of analysis developed by welfare economists over the last decade or so ... gets away from the naive position adopted by the early cost-benefit [analysts] which seemed to imply that every consideration could be perfectly weighted and that, therefore, there was a single best solution'" (Parker, 1978).

These considerations suggest that how SCBA is used should be considered carefully. However, value choices will be inherent in any evaluation method used by a decisionmaker to choose among various transit new starts, whether it is SCBA, scoring methods, or multiple measures. These value choices should be fully disclosed and made explicit. By making explicit assumptions about values, SCBA offers a framework for discussing the value choices that, under different evaluation methods, might otherwise remain hidden in the minds of decisionmakers. This document attempts to begin such a discussion by proposing a monetary value for time and emission reductions.

Scoring Methods

Scoring methods represent an attempt to condense a multiple-objective choice decision to a single index basis *without* SCBA's concern to use marketplace-based values to convert nonmonetary impacts into dollar terms. The theory underlying this approach is that, if the decisionmakers' implicit valuation and tradeoffs of the various impacts are sufficiently homogeneous and can be established through survey research, these values can be used as weights to derive a composite score for each alternative.[18]

The main stumbling blocks lie in ascertaining the weights and in manipulating the data to compute the composite score. The surveys used to determine weights -- at least at the time when this approach was most in vogue -- rarely involve respondents in making actual or hypothetical tradeoffs of the different objectives; rather, they ask people to assign point scores, one at a time, as measures of importance, to the abstract different types of impacts. Decisionmakers have sometimes resented being subsequently presented with a single choice or a ranking of choices that they are told has been derived objectively from their own expressed values.

The computational methods often used to manipulate the data -- normalizing each impact index before weighting and adding it into the composite score -- have been called into question by Lee

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17 See Flowerdew (1972).

18 See, for example, Jessiman *et al.* (1967), Hill (1973), Cohen *et al.* (1978).

(1989a). Using data from a proposed Boston highway project, he shows that poorly conceived scoring methods can result in very anomalous findings, when compared with the SCBA standard.

He concludes:

> The difficulties of valuing impacts, of sorting them into mutually exclusive and exhaustive categories, and of quantifying elusive effects and intangible values, are not so easily escaped as casting aside one framework for another that is less demanding on its users. The primary application of scoring-and-weighting methods is in fostering the delusion that it is possible to carry out technical evaluation without having to understand benefit-cost principles.

Multiple Measure Methods

The third prototypical approach does not attempt to derive an "objectively determined" single solution or all-embracing ranking of project worthiness. Rather, the aim is to present the key technical facts to the decisionmakers as accurately, as clearly, and as concisely as possible, in a way that highlights the tradeoffs that must be made among the multiple objectives. In a way, the presentation of product test findings in *Consumer Reports* magazine provides one model for how this approach can be implemented.

This approach implicitly recognizes that it is rare that societal decisions are made on clear technical merit alone, particularly in circumstances where there is significant uncertainty in assessing technical merit.[19] The analysts do not try to second-guess the judgment, intuition, and political acumen of the decisionmakers. However, the value and integrity of the approach hinge on several factors that all involve judgments: the unbiased choice of the various measures to be presented, the complexity and clarity of the presentation, and the level of consensus among decisionmakers.

The British experience is again instructive here. Arraying the pros and cons of alternative investment options, in a manner that emphasizes the *distributional* implications (who benefits and who pays?), was first developed by Lichfield, who called the method a "planning balance sheet."[20] In light of the public objections to SCBA in the appraisal of new highway proposals (mentioned in the earlier Button quotation), the British government established an Advisory Committee, chaired by Sir George Leitch, on "trunk road assessment." The Leitch Committee recommended the adoption of a single appraisal framework comprehending all types of impacts thought important, irrespective of measurability, in a format similar to Lichfield's planning balance sheet.[21] The intention was to augment (rather than replace) the existing SCBA methods, to take better account of the environmental and land use "externalities" that are difficult to value, and to focus greater

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[19] In a survey of capital budgeting methods in use by public transportation authorities in several major cities, Charles River Associates (1987) observed that the highest level allocation decisions were not based solely (or even largely) on objective criteria in any city studied, and that improving the capital budgeting process is at least as much a matter of institutional dynamics as it is of economics or finance.

[20] Lichfield and Chapman (1968); Lichfield *et al.* (1975). In some applications, point scores have been assigned to each "line item" of the balance sheet to derive a compendium measure, but we believe that the arraying of the data and the emphasis on distributional impacts are the major hallmarks of this approach.

[21] UK Department of Transport (1977). Beesley and Kettle (1979) argue that the proposed framework would be impractical or unsatisfactory in various ways, and of itself is unlikely to dispel the public's dissatisfactions with the process.

attention on distributional impacts. It was hoped that this change would engender greater public acceptance of the official appraisal process.

4
Proposed Changes to FTA's Appraisal Methods

GENERAL STRATEGY

Assessment of Options

As described in Chapter 2, recent FTA work on alternatives analysis requirements and the evolution of FTA planning guidelines have gradually moved the AA/DEIS phase of planning closer to an SCBA framework.[22] Appraisal methods that require a comprehensive delineation and estimation of the net social benefits for various alternative investment proposals,[23] as called for in the Executive Order, will improve local decisionmaking and greatly aid the Federal need to select among candidate projects. The benefit/cost ratio, if computed using tightly standardized methods, could provide a single decision variable that takes account of almost all the considerations listed in the post-ISTEA Section 3(i).

However, the earlier discussion of different appraisal approaches suggests that, *in practice*, a single benefit/cost ratio is unlikely to immediately resolve all concerns and gain universal acceptance among the various constituencies interested in the process. The current lack of Government- wide standard or even widely accepted monetary values, or in some cases even valuation approaches, for many of the benefits of transit investments, makes use of SCBA alone particularly problematic. Nor do scoring methods -- using opinion survey-based weights rather than shadow prices[24] to condense the disparate impact measures into a single index -- necessarily add any credibility or intellectual integrity to the process.

Recommended General Strategy

Based on the assessment made in this paper, FTA plans to modify its Major Investment Policy to utilize a multiple measure method, based on the tenets of SCBA. Findings of project justification would be based on a small range of different measures to summarize the main impacts of candidate projects along the dimensions spelled out in Section 3(i). The measures will be chosen to satisfy, as far as proves practical, the five objectives delineated earlier, and to highlight the key anticipated impacts of each project. The information will be presented in terms of a quantitative and monetized measure where that is feasible, classed into quantitative ranges where the likely precision of the estimate wouldn't justify presenting the estimate itself, or classed into qualitative categories. Some measures will rely on independent expert judgment, as do the current financial

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[22] The official FTA manual for transit project planning [Ryan, Emerson *et al.* (1986, updated through 1993)] includes a section on the theory and computation of consumers' surplus as a preferred method of measuring benefits.

[23] It is assumed here that the procedures already in place to define a baseline option (the "no-build, TSM alternative"), and to measure benefits and costs relative to this option, should remain unchanged.

[24] A "shadow price" is the empirically-determined or assumed rate at which a measure of a nonmonetary effect is converted into dollars.

commitment ratings for major capital investments in transit. The information on the benefits will be arrayed in tabular form.

FTA will use the information to make funding decisions among the candidate projects by weighing how well each project does on the array of criteria overall, essentially grouping projects into those with similar merit. Within groups, projects may rise or fall depending on the particular investment policy emphasis at the time investment decisions are being made. For example, the land use criteria could be emphasized, leading to higher ratings of projects which are particularly well supported by complementary land use policies.

In deciding between two candidate projects that clearly involve a tradeoff between, for example, direct transportation costs and benefits on the one hand and environmental impact on the other, FTA officials will weigh how well each project fares on the criteria, which were laid out in ISTEA, in a manner which reflects current Federal Government priorities. The publishing of the criteria themselves will serve both as evidence that the range of impacts specified in the legislation has been considered, and as a deterrent to "arbitrary" decisionmaking. Moreover, likely intercorrelation among the impact measures will mean that rarely will clear tradeoffs among impacts need to be made explicitly. A transit investment with low ridership, and hence transportation benefits, can hardly be expected to have staggeringly high environmental or land use benefits, except in exceptional circumstances.

AN EXAMINATION OF POTENTIAL APPRAISAL MEASURES

The Appendix provides a detailed discussion of various possible measures to indicate a potential investment's worthiness. For each of the four categories of potential impacts identified in Section 3(i)(1) of the Act -- "mobility improvements," "environmental benefits," "cost-effectiveness," and "operating efficiencies" -- the Appendix defines the concept, the types of data to be used to measure it (both ideally and practically), the pros and cons of alternative choices, and consequently recommended measures.

Two elements of the appraisal in the Appendix merit specific mention. *First*, in order to test various pragmatic aspects of potential measures, information presented in the reports of nine quite varied AA/DEIS studies that were completed within the last ten years was examined. These studies were:

* **St. Louis, MO.** The central/airport corridor study (published in May 1984);
* **Denver, CO.** The North I-25 corridor bus/HOV project study (June 1989);
* **Salt Lake City, UT.** The I-15/State Street corridor study (February 1990);
* **Atlanta, GA.** The North Atlanta corridor study (May 1990);
* **New York, NY.** The Queens subway options study (May 1990);
* **Santa Clara County, CA.** The Tasman corridor study (May 1991);

* **Chicago, IL.** The Central Area circulator project (August 1991);

* **San Francisco, CA.** The BART-- San Francisco Airport extension study (March 1992); and

* **Boston, MA.** The South Boston piers/Fort Point channel project (November 1992).

These prototypical studies were used to anchor the assessment of potential evaluation measures in at least two ways. First, they were examined to see evidence of either

* the explicit presentation of data that could be used to calculate (albeit possibly approximately) some of the measures under consideration; or

* the calculation of relevant measures in the course of the study, even if the data were not explicitly provided in the report of the study.[25]

Second, insofar as it did prove possible to compute estimates of performance measures from the data provided in the report, their approximate values, range, and variance were examined as a clue to how uniformly they may have been derived, how rationalizable were major differences, and hence how meaningful a measure they might be for inter-project comparisons.

The *second* major point to note about the discussion in the Appendix is that it is directed entirely to the *Federal Government*'s role in deciding which projects should receive Federal assistance under the discretionary Section 3 new starts funding. It is *not* suggested that the local project evaluation -- the work necessary to determine the locally preferred alternative for a particular corridor -- should be based *entirely* on the types of measures examined or recommended in the Appendix. Nor is it suggested that the recommended performance measures be the *only* considerations that the Federal Government takes into account in executing its role. However, the approach being described here can provide local decisionmakers with much useful information, arrayed in understandable form. In addition, as a comprehensive analysis of many, if not all, of the most important likely benefits of transit investments is included, it is believed that most local decisionmakers would find the goals and objectives they typically see for transit investments covered.

The SCBA model -- which involves identifying, quantifying, and valuing the full range of privately and societally experienced impacts expected for each considered alternative, using *internally consistent* assumptions and procedures -- arguably provides the best pattern for undertaking local alternatives analyses. If this were done, most (if not all) of the measures recommended that the Federal government require for the preferred alternative would be simple byproducts of the exercise. But for the Federal Government to use the benefit/cost ratios emerging from such studies as the primary or sole means of choosing between them has at least two difficulties:

* There are problems of ensuring that uniform or comparable assumptions and procedures have been used across projects, without being overly prescriptive in a way that may transgress the direction (in Section 3(i)(3)) to take account of local conditions.

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[25] The data developed in this exercise have been compiled into a separate document.

* There are public credibility and acceptance issues involved in using a single index, no matter how wide the scope of the analysis has been (as can be seen both from the British experience and from the types of complaints leveled against FTA's *cost per new ride* measure). This is particularly true in the absence of Government-wide standards for the monetary values of certain benefits of transit investments, and the absence of widely accepted methods for assessing the value of other benefits, particularly land use effects.

RECOMMENDED APPRAISAL STATISTICS

FTA intends to use the following measures for determining the degree to which a project is "justified" as required by Section 3(i) and to meet the requirements of the Executive Order to assess the benefits and costs of candidate Federal infrastructure investments:

* **For "cost-effectiveness"**

  - the *total incremental costs per incremental transit*[26] *passenger-trip* (or possibly, per passenger-mile in certain cases), where the projected streams of capital costs, operating costs, and passenger-trips have been (in the case of the costs) expressed in constant dollar terms, and (in all cases) the ridership and costs have been discounted at the social discount rate. The figures would also be "levelized" so as to produce a statistic that characterizes the average year while avoiding the problems inherent in examining the situation for certain "design years" only.

* **For "mobility improvements"**

  - the projected aggregate monetary *value of travel time savings* per year anticipated from the new investment, compared with the TSM alternative. This aggregate includes the travel time impacts on people using competitive modes, along with those on the trips made by transit (both new and existing transit riders). It is a *net* figure in that travel time increases should be explicitly considered and used to offset the time savings of those people who experience savings. Each year's projected time savings would be discounted and levelized in a manner identical to that used for the *incremental cost per passenger-trip* measure. FTA plans to work towards improved forecasting methods that will allow induced trips to be appraised also. The value would be expressed in absolute terms, as well as in percentage change terms for the region. The value of the time savings will be calculated using a value of time based a standardized percentage of the local average wage rate.

  - the number of *zero-car households* (or alternatively, the people resident in those households) located within ½ mile of boarding points for the proposed system increment.

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[26] If the project goals include the promotion of ridesharing in private vehicles, the trips to be forecast would be the change in *all* HOV trips (both auto and transit).

* **For "operating efficiencies"**

  _ the forecast *change*[27] *in operating cost per vehicle service-hour* (or service-mile), for that part of the system that will be directly affected by the proposed new investment, compared to the TSM alternative. If in the rare event it can be credibly argued that there are significant economies of scale or of scope, the full system could be considered. The value would be expressed in absolute and percentage change terms, for the region.

  _ the forecast *change*[27] *in passengers per vehicle service-hour* (or service-mile), calculated on the same basis, again in absolute and regional percentage change terms, compared to the TSM alternative.

  _ the forecast *change*[27] *in passenger miles per vehicle service-hour* (or service-mile), calculated on the same basis, again in absolute and regional percentage change terms, compared to the TSM alternative.

* **For "environmental benefits"**

  _ the monetary *value of the forecast change*[27] *in criteria pollutant*[28] *emissions and in greenhouse gas emissions*, ascribable to the proposed new investment, compared to the TSM alternative. The measure should be expressed in tons per year (or per day), and calculated in present value terms by discounting and levelizing in a manner identical to that used for the cost-effectiveness measure. The value would be expressed in absolute and percentage change terms. The monetary value will be calculated using standardized unit values for emission reductions, based on EPA-based analyses of the costs of alternative means of achieving emission reductions.

  _ the forecast *change*[27] *in the consumption of fuels of different types*, ascribable to the proposed new investment, again discounted and possibly levelized. Again, the value would be expressed in absolute and percentage change terms, compared to the TSM alternative.

* **For "transit supportive existing land use policies and future patterns"**

  _ the degree to which local land use policies and the development market are likely to foster transit supportive land use, measured in terms of the degree to which local land use policies are supportive of the proposed transit investment, and commitment to the these policies.

This set of indicators addresses the major issues identified in the revised language of Section 3(i), as well as the goals of the Executive Order. Moreover, while there are some obvious interrelationships among the indices, "double-counting" is minimized by keeping them as

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[27] That is, the difference between the forecasts for the selected alternative and for the baseline condition.

[28] "Criteria pollutants" are those air pollutants for which specific standards have been set under the Clean Air Act Amendments, such as Carbon Monoxide. It is suggested that a separate measure be computed for each major type of emission for which the subject city is in nonattainment status.

independent as possible. While the measures focus on both transportation and non-transportation benefits, they are transit-specific, and are thus focused on the Federal determination of the merit of a project for discretionary Section 3 funding. Nevertheless, the approach being followed can form a basis for multimodal comparisons.

In particular, it should be noted that a different approach to measuring "cost-effectiveness" considerations is being proposed than that used by FTA in the past. The *incremental cost per new transit ride* measure attempted to internalize mobility effects by using monetized time savings as an offset to costs. The threshold values specified for the statistic implicitly made liberal allowance for the inclusion of environmental and safety issues on a comparable basis. For the new recommended measure, it is intended that "costs" be construed more narrowly, to comprise only the monetary value of construction and any change in operating costs. This is because the mobility and environmental considerations are now addressed explicitly by other recommended measures.

Another major difference in the proposed new cost-effectiveness measure is that it includes annualized, levelized costs and ridership differences calculated over the analysis period, rather than costs and ridership differences calculated based on a single forecast year. While past practice has included estimates of costs on a year-by-year basis over the analysis period, accurate assessment of the ridership impacts could involve multiple ridership forecast (say for the year of opening, the forecast year, and the year at the end of the analysis period). On the other hand, it may be possible to synthesize forecasts of the year of opening and year at the end of the forecast period using forecast year results and well known factors relating typical trends in ridership for new transit investments. FTA is interested in obtaining views on how much additional effort would be required to calculate estimated ridership impacts for multiple forecast years. FTA is also interested in views on how much accuracy would be gained by such multiple forecasts, compared with reliance on synthesized forecasts based on typical trends in ridership growth.

It should also be noted that the approach for valuing travel time savings will be changed from past practice. In the past, FTA specified use of $4.80 per hour of travel time savings and $2.40 per hour of travel time savings for non-work trip, for use in calculating the offset to costs. This value was based on the a factor of 40 percent of the national average wage rate for work travel, and one-half this amount for non-work travel. Recent analysis of the valuation of time in other programs of the Department of Transportation and elsewhere in government suggests that this value is inconsistent with these other practices. For example, analysis of models used by the Federal Highway Administration indicates use of a much higher factor of wage rates for travel time savings. Accordingly, FTA is participating with other elements of the Department to develop consistent approaches for valuing travel time savings. In the interim, FTA expects to use a factor of 80 percent of the local wage rate for calculating the value of travel time savings.

Similarly, in the past FTA did not attempt to value the environmental benefits of transit investments. The benefits of emission reductions can take a variety of forms, such as improved visibility, crop yields, and public health. The Environmental Protection Agency (EPA) is currently developing, pursuant to Section 812 of the Clean Air Act, standard monetary values of such benefits. The results of this analysis are expected to be available in 1995, and may be useful in evaluating the environmental benefits of transit.

Absent standard values of the benefits from emission reductions, avoided cost is an inferior, but potentially useful approach. The avoided cost approach, which generally is only applicable to nonattainment and maintenance areas, uses standard unit costs of pursuing alternative means of achieving emission reductions as a proxy for the benefits of such emission reductions. Some EPA analyses have, in the past, used the avoided cost approach.

Pending further analysis by EPA and additional work by FTA with other agencies within and outside the Department of Transportation, FTA intends to use values based on avoided cost as an interim proxy for the benefits of emission reductions in the relevant nonattainment/maintenance areas.

The standard unit values proposed in this document are based on nationwide averages and, therefore, do not reflect the fact that the cost of achieving emission reductions by alternative means varies depending on project location. If the environmental impacts of a proposed transit project are significant, additional analysis to develop an avoided cost relevant to that specific nonattainment/maintenance area would be appropriate.

Examination of the nine prototypical AA/DEIS studies suggests that these new indices should be calculable in the alternatives analysis phase of planning without significant extra work for local sponsors.

FTA intends these measures to apply to projects which have not yet completed the Alternatives Analysis process. Projects which are now in Preliminary Engineering would not be required to do the additional analysis. They would be evaluated based on data already available.

OTHER CONSIDERATIONS

The recommended measures listed above do not include explicit consideration of noise emissions or energy security considerations. The Appendix includes some discussion of (and suggestions for) measures that address these topics. However, the evidence from examination of past studies suggests that the noise and energy security effects are likely to be quite small, and very unlikely to tip the balance for or against any specific projects. Transit projects are usually analyzed to have negligible effects on noise emissions, or else deleterious effects meriting mitigation. Energy security considerations have been valued at a few cents per new transit trip at best; this is hardly large enough to offset the levels of differences observed between transit projects.

FUTURE IMPROVEMENTS

As noted earlier, SCBA forms a useful tool for analyzing the worthiness of public investments. However, the key to successful SCBA is the proper accounting for and monetizing of the full range of the benefits of a proposed investment. It is FTA's belief that while it is possible to quantify and monetize many of the benefits of transit investments, as evidenced by the approach being proposed here, ascribing a monetary benefit to some of the benefits is particularly difficult. This is particularly true in the absence of Government-wide standard values for some of the benefits which may be ascribed to transit projects. In addition, there is an absence of general

agreement on even the valuation of certain other benefits, such as those related to the land use effects of transit investments.

This lack of current Government-wide standard values or generally agreed valuation is the key reason why FTA did not choose to use only SCBA in the approach described here. FTA intends to conduct research into the valuation and monetization of the benefits of transit investments in order to develop an accepted approach. As this research proceeds, FTA intends to apply it to the quantified benefits of the investments being considered, in order to move closer to a complete SCBA approach. This research should permit FTA to begin to construct partial indices of costs and benefits as part of its evaluation of project worthiness. With time, more complete indices can be constructed, ultimately resulting in a full-fledged SCBA approach.

APPENDIX
An Appraisal of Candidate Project Evaluation Measures

MEASURES OF "COST-EFFECTIVENESS"

Developing specific statistics to characterize the relative cost-effectiveness of transit capital investments requires resolution of several issues. Both "cost" and "effectiveness" need to be defined. Then, given that new starts involve investments that perform over many years, the appropriate way to handle the *timing* of both costs and effectiveness needs to be established. Finally, the "cost per new transit trip" measure that has been in use since 1984 is a form of cost-effectiveness measure, and it needs to be evaluated to see how it compares with other possible cost-effectiveness measures.

Review of the relevant literature and practice suggest that effectiveness is best defined as either additional trips or passenger miles on transit. Cost is best defined as the total cost of the proposed investment, capital and operating, compared with the base case. Timing is best handled by "levelizing" costs and effectiveness to a discounted annual equivalent. Thus, the recommended measures of cost-effectiveness are *incremental cost per new transit rider* and *incremental cost per new transit passenger mile*.

Effectiveness of Transit Investments

In recent years, much has been written about the monitoring and evaluation of transit performance, more commonly in connection with operating performance rather than with capital investment.[1] "Effectiveness" is usually taken to connote a measurement of the amount of end product delivered to and consumed by the public: it includes a measure of *demand* and not just of *supply*. While "*efficiency*" can be characterized in terms of supply-side measures alone (such as vehicle-miles, seat-miles, vehicle-hours, and so on), "*effectiveness*" is better characterized by such demand-side measures as passengers, passenger-miles, fare revenues, or user benefits.

Since prospective transit projects are designed to move people, one clear measure of the effectiveness of such investments is the number of trips that are forecast to be carried on the new system. Measuring effectiveness in terms of ridership has the advantage that most new passenger transportation investments are evaluated in this way, so that the measure can be used in some intermodal comparisons.

The disadvantage of using total ridership as a measure of effectiveness is that different types of rides can vary in the *cost* of providing them, and also that different types of rides can vary in terms of the *benefits* associated with them. For example, rides on transit new starts that are made by

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[1] Fielding (1992) provides a succinct overview of this literature. Fielding, Glauthier, and Lave (1978) developed a range of different indicators appropriate to performance assessment, and Fielding, Babitsky, and Brenner (1985) explored the properties of such indicators for bus systems, using FTA "Section 15" data.

former single occupant vehicle (SOV) commuters may have a more positive environmental impact than rides that are made by individuals diverted from existing transit services. Alternatively, rides made in the peak period may have more impact than trips made in off-peak periods, since new peak period rides are more likely to alleviate highway traffic congestion.

The concern about differential benefits associated with different types of trips can be dealt with by tracking the ridership benefits explicitly, as is called for in Section 3(i) of the Federal Transit Act (FT Act), as amended by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The mobility or environmental benefits associated with different types of trips can be measured separately, or included in the calculation of the net cost in a manner similar to the calculation of the current *cost per new transit ride* index.

However, it is true that different types of trips can cost different amounts to provide. All trips are not the same, which complicates the comparison of cost-effectiveness indices across cities. For example, trips on San Francisco's BART system generally are longer than trips on Boston's Red Line extension, so that comparing rides per day on the two systems ignores the fact that the BART system does more work in moving people. Thus, the costs per ride on the two systems are not strictly comparable since the trip lengths are so different.

Because of such potential differences in trip lengths, effectiveness in transportation systems is sometimes measured in terms of person-miles rather than in person-trips. A system that has trips averaging twice the length of those on another system might reasonably be expected to exhibit higher costs per ride. Such a higher cost per ride may not necessarily imply a less cost-effective system, but rather one that has rides producing social impacts or generating savings that are larger.

So while both person-trips and person-miles are reasonable alternative measures of effectiveness, deciding which one is a more meaningful characterization of the benefits of alternative investment options for *a particular corridor* should be influenced by whether the *production* of a transit trip or the *length* of the trip will better represent the goals of the enterprise. For example, if the primary objective of a new transit proposal is to provide mobility options for those who do not currently have access to private vehicles, then short trips may have almost the same impact as longer trips in improving mobility, and person-trips may be an appropriate output measure. If reducing dependence on petroleum use is a primary objective of the proposed investment, then longer trips may be expected to have more of an impact than shorter trips. In this situation, person-miles traveled may be the more appropriate output measure.

With today's cleaner cars, a significant portion of the air pollutant emissions comes from the beginning of an automobile trip, before the catalyst in the exhaust system has heated up to maximum efficiency. Consequently, emissions are not proportional to VMT, and diverting short auto trips may have almost as much air quality benefit as diverting longer auto trips.

If a primary objective of the new transit proposal is to reduce traffic congestion, either person-miles traveled or person-trips may prove to be the more appropriate measure of effectiveness. Although in some dense road networks congestion may be broadly proportional to VMT, more typically it is concentrated in just a few parts of the metropolitan area (such as the downtown), and both short and long transit trips may make equivalent contributions to congestion

reduction. Thus, as with the emissions objective, both the person-trips and the person-miles traveled may be useful effectiveness measures.

Cost-effectiveness measures based either on the forecast person-miles traveled or on the forecast person-trips both have direct intuitive meaning. Using person-miles traveled facilitates comparisons with taxi fares or auto costs per mile. For example, many tripmakers are familiar with cost estimates of about 28 cents per mile for cars (based on the current IRS allowance level for business deductions) and about $2.00 per mile for taxis. The use of person-trips as an effectiveness measure leads to cost comparisons based on the *total* out-of-pocket costs of taxi or driving.

The choice of the more appropriate effectiveness measure for deciding between alternatives in a specific corridor should be influenced, at least in theory, by the primary objectives of the project and the extent to which either person-trips or person-miles might better correlate with those objectives. From the Federal viewpoint (weighing the relative merits of projects across cities), it would certainly be more informative to have *both* measures of effectiveness available. If, in the interest of simplicity, one or the other has to be chosen for presentation, the correlation between them may be expected to be so high that in many cases it wouldn't really matter which were used. In a choice between the two, *passenger-trips* is marginally preferred, primarily because of considerations of continuity, familiarity, and ease of calculation.

Review of the nine alternatives analysis reports found that all produced forecasts of passenger-trips. However, few included either explicit estimates of passenger-miles or data from which approximate passenger-miles figures could be constructed. If the more usual "synthetic" method is being used to generate the demand forecasts, it should be feasible (and probably easy) to produce passenger-miles estimates. It may be more difficult and burdensome to do so if the "incremental" forecasting method is being used. The historical transit passenger-miles data are likely to be somewhat less accurate and precise than the figures for unlinked or linked transit trips.

Interest in using person-miles traveled as an alternative to person-trips for measuring effectiveness may increase if and when more systems adopt distance-based fare systems, made possible by improvements in fare collection technology. If distance-based fares are in place or are being seriously considered, evaluating alternatives in terms of passenger-miles may have some advantages.

Another key issue in determining the effectiveness measure relates to use of a base case for analysis. In the present approach, the base case is the TSM alternative, sometimes known as the "best bus" alternative where there is not currently a rail facility in the corridor in question. This alternative includes those low-capital and operational improvements which can be made to improve the efficiency and effectiveness of the existing transit system. This base case is used to focus the analysis on the capital investment in question, by normalizing the analysis for these sorts of improvements.

Many have argued use of the TSM alternative as the base case undercounts the benefits of the proposed new investment. Others have questioned the feasibility of the TSM alternative, arguing that it is often not possible politically to generate the level of interest needed to make changes of this nature, which often are quite costly, and can be controversial.

Nevertheless, use of an alternative which controls for the effects of improving the existing infrastructure before making major new investments is good planning practice. It focuses the analysis on the capital investment. Further, it assures that city-to-city comparison of projects are fair because no city can claim that the benefits of basic improvements in transit are the result of the capital investment.

For these reasons, it is proposed that the TSM alternative remain the base case for calculating cost-effectiveness, as well as the other project justification measures. In this way, fair comparisons can result, and only the impacts of the capital investment being proposed will be evaluated. Thus, the effectiveness measures being discussed here will be incremental passengers or passenger-miles, compared with the TSM alternative.

Cost of Transit Investments

The costs of transit investments are a measure of the resources foregone to build and operate the system. Narrowly defined, costs comprise the system capital and operating expenses. More broadly defined, costs can be construed to include environmental and mobility factors such as congestion reduction.

The narrow definition of costs provides insights into the direct resources consumed to use the system, while the broader definition includes spillover considerations that are relevant for a public investment. Narrow costs would be those viewed by the prospective builders, operators or financers of a privatized system.

Deciding how broadly to define costs depends in part on the choice of the other transit performance measures developed to assess new starts. For example, if the forecast impacts on traffic congestion are being tracked with specific measures of mobility effects, then it would not be wise to include its impacts in the cost-effectiveness index also. As much as possible, the set of measures chosen to provide descriptions of new-start proposals should not overlap. Consequently, the wording of the revised Section 3(i) appears to be more closer to a *narrow* definition of costs for the cost-effectiveness measure than to a broader one to allow for more discrete analysis of each benefit, rather than attempting to develop compendium measures which attempt to cover all costs and benefits at one time.

Accounting for the Timing of Costs and Effectiveness

Capital costs mostly occur in the early years of the project, prior to opening for service, while operating costs and ridership occur in later years. Costs and ridership accruing in different years have different levels of importance, with near-term impacts being more important than impacts projected to occur in later years.

To account properly for the distinctions caused by the timing of investments, both the costs and the ridership need to be discounted by the "social cost of capital." Discounting *both* the annual costs and the annual ridership projected for new starts results in single measures of each, expressed in terms of today's dollars and values. These discounted values could be divided directly to provide a cost-effectiveness measure, or converted to more intuitive measures.

"Levelizing" the costs and the effectiveness, after discounting them, is one way to make the statistic more intuitively understandable. Levelized costs are derived by calculating a uniform annual cost over the life of the new start that, properly discounted, results in a net present annual cost which is equivalent to the discounted cost of the actual expected cost streams, producing an "average year" cost. Levelized ridership is simply the uniform annual ridership level that, properly discounted, results in a present value of ridership equivalent to the discounted value of the actual expected ridership, again in an "average year."

Using levelized cost and effectiveness measures will not change the results from using net discounted values, but will provide annual cost and effectiveness measures that can be related more easily to actual projections in new-start applications. The result is thus the cost-effectiveness in an "average year."

At first impression, it may seem unreasonable to discount a physical effectiveness measure in the same way that a financial cost measure would be discounted. However, the effectiveness measure is correlated with -- and a proxy for -- the benefits produced by the investment. If the value of those impacts were monetized (as they would be in a social cost/benefit analysis), then it would not seem unusual to apply discounting procedures.

Calculating discounted (or levelized) costs and effectiveness is preferable to analyzing a selected "typical year," projected 10 to 15 years after the system opens. Although estimating the effectiveness and costs in a selected year does not involve discounting, it is misleading to ignore the true costs and effectiveness associated with the startup years of the proposed project.

On the other hand, calculating discounted (or levelized) effectiveness is likely to increase the complexity of the analysis needed. For the most accurate estimate, effectiveness (ridership) in each year of the forecast period would have to be calculated. However, since year to year changes in ridership are likely to be small, it is possible to achieve an equally accurate estimate by calculating ridership impacts for a smaller number of forecast years. For example, ridership could be calculated for the year of opening, the last year of the forecast period, and some year in between. The present approach uses a "typical year," usually 15 years from the current year (e.g., for analyses conducted in 1994, the forecast year is 2009). Adding the year of opening and final year of the analysis period (current practice is 30 years), would increase the level of effort significantly, although it would not be a tripling of level of effort since the methods used would be the same. However, separate forecasts of exogenous factors (such as population and employment levels and patterns) would be required.

An alternative approach would be to rely on a single forecast year, applying standard transit ridership growth patterns to calculate year-by-year ridership levels. Research has shown that transit projects typically generate about 80 percent of "stable" ridership in the first year of operation, 90 percent in the second year, and 100 percent in the third year. After that, ridership tends to grow on a secular basis with regional growth in population and employment (typically 1 or 2 percent per year). Using this pattern, together with a "typical year" forecast, would produce a consistent year-by-year ridership pattern for calculation of discounted, levelized ridership, which is unlikely to be significantly different from the results of developing detailed forecasts for more than a single year. FTA is interested in comment on how much more accurate multiple forecast years would be and how much additional effort is required to develop such multiple forecasts.

Using the Existing "Cost Per New Ride" Concept to Measure Cost-Effectiveness

The current *cost per new transit ride* index provides a now-familiar measure of cost-effectiveness. It focuses on *new rides* (passengers assumed to have been diverted from private vehicles), rather than *total rides* or *person-miles* traveled, as the effectiveness measure. However, the current index also includes the net time savings for existing riders. In effect, the effectiveness measure can be viewed as encompassing total rides, but the benefits to existing transit riders are valued in money terms, and converted to a cost offset. Thus they are considered, but are accounted for separately from the "new" rides.

Besides the monetized value of travel time savings for existing riders, the concept of cost and benefits in the current cost-effectiveness index is a broad one, recognizing not only the capital and operating costs, but also congestion reduction, environmental improvement, and net savings to riders diverted from automobiles. As such it includes several concepts that, in response to the reworded Section 3(i), are probably better tracked by other independent measures of mobility and environmental impacts.

The *cost per new transit trip* index measures effectiveness in terms of passenger-trips, not passenger-miles. Switching to a passenger-miles basis for the index, while retaining the cost offsets for travel time savings, implies more than merely a substitution of "new passenger-miles" for "new trips" in the denominator of the index. Projects that will cater to longer transit trips might conceivably generate bigger savings for existing and new passengers. In other words, an index based on passenger-miles would require adjustment to the interpretation of the current index which would go beyond simply adjusting the index value for the average trip length.

Recommended Cost-Effectiveness Measure

Alternatives analyses should calculate dual measures of cost-effectiveness of transit system new starts, based both on incremental transit person-trips and person-miles traveled. The incremental effort involved in calculating and reporting both of these effectiveness measures will be small.

Since it is proposed that multiple evaluation measures be used to represent the range of considerations now spelled out in the FT Act, the existing measure of cost-effectiveness -- the cost per new ride calculated in a standardized way intended to internalize a broad range of benefits and costs, as a proxy for a social cost/benefit ratio -- should be modified by deleting the travel time savings credit in the numerator. In the world of the new Section 3(i), mobility benefits would appear to be better addressed by separate measures. This change to the existing measure would narrow the definitions of both costs and effectiveness, reducing it to a much simpler *incremental cost per incremental passenger* or *incremental cost per incremental passenger-mile* index, compared with the TSM alternative.

MEASURES OF "MOBILITY" IMPACTS

The new language of Section 3(i) charges the Secretary of Transportation to take account of the mobility impacts of proposed new starts in two ways:

* by accounting for the cost implications "related to . . . improved mobility . . . (and) congestion . . .", and

* by identifying and considering the degree to which the project "increases the mobility of the transit dependent population or promotes economic development."

It is first necessary to define improved mobility, and the cost savings or benefit increases that result from it. Possible statistical measures of these effects will then be examined and recommendations made. Based on the review, it is recommended that *the value of travel time savings* and *number of zero-car households within 1/2 mile of the new facility* be used as measures of mobility.

Defining Improved Mobility and Associated Cost Savings

Mobility is improved if individuals can complete the trips they currently make at lower net costs, or if they can and do make more trips in response to a lowered net cost of tripmaking. "Costs," in this context, are meant to include not only the out-of-pocket monetary payments made for their travel, but also the monetized value of service quality differences, most importantly in travel time. Thus the usage of the word "costs" is equivalent to what are sometimes referred to as the "generalized costs" of travel.

In other words, the most significant hallmark of improved mobility is that the generalized costs of travel have decreased, thereby increasing the "consumer surplus"[2] of the people traveling in the affected region. The most meaningful measure of this change in mobility is the change in consumer surplus.

The savings in generalized costs for those individuals currently making trips is simply the difference in the generalized costs of their trips before and after the new investment is placed in service (or between the base case forecast and the forecast for the proposed new start).
The cost savings from making more trips are less straightforward, since the *payments* of money and time for transportation actually *increase*, relative to the baseline situation, where the trips were not made at all. But while it is true that transportation costs increase, it is also true that the new transportation system creates an *opportunity* for tripmakers that did not exist before. By taking advantage of this opportunity, the tripmakers benefit. The satisfaction they get from expenditures on new trips obviously exceeds the satisfaction they formerly received on spending their money and time in other ways, otherwise they would not now be making the new trips. The extent to which they are better off -- their change in consumer surplus -- is a measure of increased mobility for them.

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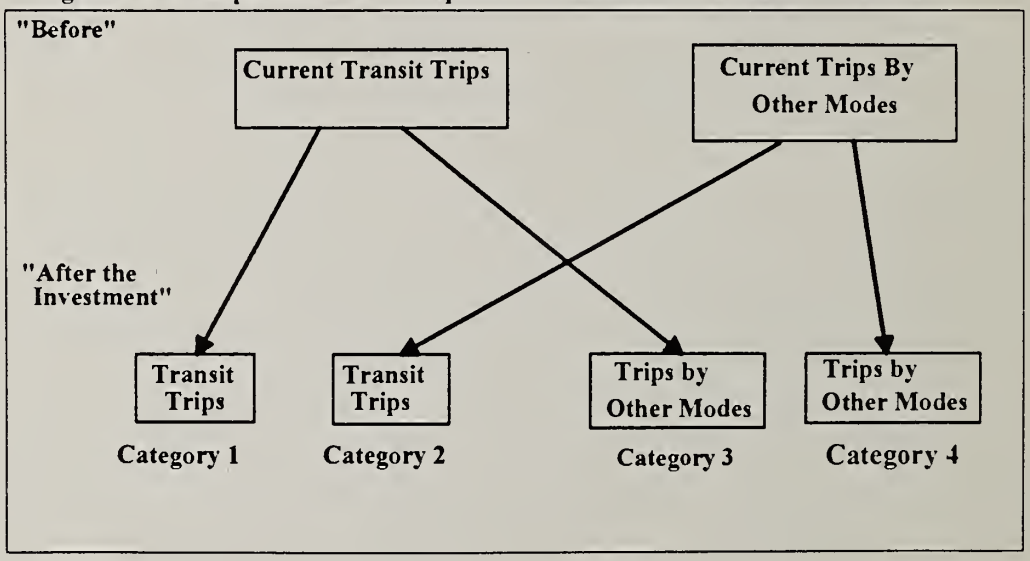
[2] Defined as the difference between what consumers actually "pay" versus what they would be willing to "pay," taking into account all of the benefits to the consumer.

The tripmakers who benefit most directly from the improved mobility and the associated cost savings are the *users* of the new transit system. But insofar as the new system relieves congestion on the highways or on other parts of the transit system, there may be gains to existing and new tripmakers who are not themselves using the new investment. Gains to these users may be significant changes to regional mobility.

Section 3(i) highlights in particular the mobility gains of the *transit dependent* population, suggesting that they should be considered separately from the gains to the entire population. Consequently, separate accounting needs to be made for these individuals. By "transit dependent," we take the congressional intent to include not only those people who, because of financial or other reasons, have few alternatives before the new investment but to use transit, but also other low-income or low or zero-car-ownership individuals newly served by the investment. In other words, the concern is assumed to be less with the people who are currently "captive to" transit services than with the people living in low-car-ownership households, regardless of they are currently traveling.

Figure A1 provides a simple characterization of modal diversions brought about by the introduction of a major new transit service. Consider the current pattern of tripmaking in the relevant area, and distinguish between those trips now made on the existing transit services and those made by other modes.[3] After the proposed major transit investment has been put into place and ridership has reached a steady state, these "same trips" will have been redistributed in the fashion summarized by the figure. The new investment has changed the generalized costs of travel in the corridor by each of the two options, and the trips have been redistributed as a result of these changes. The net mobility impact for an "existing trip" is best measured by the change in

Figure A1. A Simple Model of Transportation Benefits from a Transit Investment



[3] There are good reasons for wanting to distinguish these "other modes" individually, but the traditional model used in these circumstances focuses solely on trips made by private vehicles, at the existing average occupancy rate. People are assumed to choose solely between "auto" and transit travel. In well-defined commuting corridors this may be a reasonable representation of the real world, at least in the peak periods; for off-peak, or

the generalized costs of that trip. The aggregate mobility impact is that change summed over all the trips.

But any significant increase in the transportation infrastructure is likely to induce some *additional* trips as well. The new transit capacity can be expected to induce both some new trips by transit and also new trips by highway if there's been any significant favorable impact on traffic congestion. In any complete accounting, these induced trips need to be forecast and valued.

For several reasons, the forecasting methods used in most AA/DEIS studies are not very good at estimating induced trip effects, and project appraisal measures have typically ignored them. The mobility impacts that are typically looked at are those arising primarily from modal shifts, assuming fixed total numbers of trips made between specified origins and destinations.

The savings in generalized costs that accrue to the tripmakers in all of categories 1 through 4 have three major and different dimensions:

* **Out-of-pocket monetary savings.** New transit investments can attract riders by offering a less-expensive mode of transportation. For example, a new start might include park-and-ride facilities that enable some commuters to avoid driving and parking downtown, with a resulting net direct cost saving to them.[4]

* **Net time savings.** New transit investments will typically provide faster trips for many commuters that formerly used buses operating on congested surface streets, and slower trips for other users now forced to transfer or take more circuitous routes. Commuters switching from private vehicles to transit can also achieve travel time savings. In addition, insofar as traffic congestion is reduced, the surface bus system and people traveling in private vehicles may realize some net time savings as well.

* **Reliability, convenience, and comfort improvements.** A new transit investment will typically provide a level of service quality that is higher than that provided by the systems it expands or replaces. Such improvements -- which may reflect greater reliability, fewer transfers, or lower in-vehicle crowding -- are likely to have some value to the customers.

When a trip that was previously made by another mode is projected to be diverted to transit as a direct result of the proposed new investment, the magnitude of the benefits (on all three of these dimensions) should be measured relative to the *transit service* offered previous to (or without) the new investment, and not relative to the price, travel time, and other significant service characteristics of the *mode currently used.*

The increased travel on transit raises one important definitional problem, which is how to value the new trips made by transit dependent populations. Typical economic calculations value new trips by measuring the consumer surplus that is created for each new tripmaker. Using consumer

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reverse flow, or intersuburban trips, it may be too great an oversimplification or mischaracterization of the situation.

[4] There may be long-run as well as short-run cost impacts, to the extent that the new investment influences automobile ownership levels and land-use patterns. Generally speaking, however, there are good reasons to be hesitant about incorporating long-run effects; they are discussed further in Chapter 3.

surplus to measure increased mobility focuses on the *private* gains to the individual. Through its various programs to assist transit dependent populations, the Federal government has demonstrated a "*social* willingness to pay" to achieve increased mobility for these people, over and above the private gains that accrue directly to them. That is, increased mobility for the transit dependents is especially highly valued, and gains in mobility for them are particularly important. The question arises as to how the societal, as distinct from private, willingness to pay should be considered and measured.

Measuring Improved Mobility

The next part of this section will discuss first an approach to measuring mobility impacts that takes account of all of the factors discussed thus far. This is followed by a discussion of some compromise measures that come closer to the information and analysis typically undertaken in past alternatives analysis studies.

"Complete Measures" of Mobility Impacts

To assess how best to measure completely the improved mobility that results from a proposed transit investment, it is useful to examine what is known quantitatively about the factors influencing the demand for the proposed investment. Forecasts of the patronage for the new investment will be based, explicitly or implicitly, on a demand model (or a modal choice model), the coefficients of which are likely to characterize traveler valuations of (for example) line-haul or door-to-door travel time savings and service frequency. Moreover, the model is likely to include "mode-specific (or modal) constant" terms, that characterize the net effects of particular features of each mode beyond the travel time and cost considerations that are treated explicitly in the model. Consequently, the modal constants are serving proxy for such aspects as the reliability, convenience, and comfort of the different available choices.

For the *existing transit users*, the valuations that are implicit in the demand model coefficients and mode-specific constants can be employed to translate projected net time savings (and possibly other service quality improvements) into monetary terms. It is important to stratify the market into segments believed to have relatively homogeneous values of travel time, which implies that it would be preferable to do these calculations separately for commuters, off-peak or occasional users, and transit dependent populations, if the available data permit. Moreover, since the people who are currently riding transit are likely to have different average values of time savings than those using private vehicles, this analysis should be stratified by the mode currently used.[5] For *new users*, the same transportation demand models could be used to compute the equivalent net savings in generalized costs, by comparison with the TSM alternative.

With a good knowledge of the mode choice utility functions for the varied market segments, and some analysis of the historical growth of total travel in the corridor, it is possible to forecast the induced travel based on the change in the overall level of service offered by the improved transportation system.[6] The consumer surplus associated with this induced traffic can also be estimated.

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[5] Brand *et al.* (1992) argue the importance of segmenting the market by existing choice in developing demand or mode choice models.

[6] Brand *et al.* (1992).

Proxy Measures for General Mobility Impacts

However, this discussion of "complete measures" implies a level of data collection expenditure and analysis effort that is significantly greater than has been expended in most AA/DEIS studies. It's likely that simpler proxy measures will be necessary to give an approximate indication of the likely mobility impacts of different projects. Considering first the market as a whole, three proxy approaches commend themselves:

* **Track time savings only.** One approach would be to forecast the *net travel time savings* of existing tripmakers. This approach ignores money and convenience savings, and all mobility gains from induced trips.

* **Track travel time and cost savings only.** This approach would be similar to the first one, except that out-of-pocket monetary savings as well as time savings would be forecast. Out-of-pocket money savings may be somewhat suspect as a benefit measure because they will depend in part on the fare policy assumed by the transit authority.

* **Track travel time savings and estimate induced trips.** This approach would be similar to the first one, but would add a forecast of induced trips, without making an effort to assign a value to the increased mobility of those induced trips.

The examination of the nine prototypical alternatives analysis reports shows that it is rare for the published documents to present information about net travel time and monetary impacts on travelers.[7] However, these data are usually calculated at some point in the analysis for use in the mode split model. It is conceivable that the estimates of time and cost savings implicit in the equilibrated design network could be obtained without much extra effort.

The concept of induced trips is foreign to the "synthetic" process usually used to forecast the impacts of a transit investment. In the typical Alternatives Analysis -- Draft Environmental Impact Statement (AA/DEIS) study, the land use patterns and the trips generated by them are usually exogenous inputs to the forecasts, developed by the local Metropolitan Planning Organization (MPO) and insensitive to the performance of the transportation system. It is unlikely that any substantiated forecasts of induced trips could be calculated without significant additional work in these studies.

This suggests that, at the present time, the best measure would focus only on travel time savings. However, once travel time savings are calculated, the next step in calculating a proxy measure can be to ascribe a monetary value to these savings. As noted above, there may be differences in the value of time for different users and trip purposes. However, for the purposes of developing a proxy measure, certain simplifying assumptions can be made, particularly to ensure consistency between the analyses conducted on transit projects and those conducted for projects in other modes and under different infrastructure programs.

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[7] Often, the report will cite an average trip time on the new transit network compared with the old. But applying this trip time to the number of *new* rides doesn't allow one to evaluate the benefit of the new service without some knowledge of their previous trip times.

In the past, FTA has used a factor of $4.80 per hour of work-trip travel time savings and $2.40 per hour of non-work trip travel time savings. This was based on earlier work for FTA which suggested that 40 percent of the National average wage rate was an appropriate value to use in valuing the current transit user travel time savings for calculation of the former cost-effectiveness index. However, recent analysis has shown that this value is substantially less than the value used in analyses of projects in competing modes. For example, a current model used by the Federal Highway Administration (FHWA) suggests use of 80 percent of the average wage rate for both work and non-work travel. The Federal Aviation Administration (FAA) uses an average value of time of $42.00 per hour, based on 100 percent of the wage rate for business travel, and a factor equal to 150 percent of the wage rate for leisure travel. These factors were developed by assessing the behavior of travelers in trading off time and cost savings.

In order to assure consistency, FTA intends to work within the Department of Transportation to develop a uniform approach to valuing travel time savings. The result will be a single uniform basis for analyzing the value of travel time savings, and will be consistent with the approach used by all competing modes. In the interim, FTA proposes to value time at 80 percent of local wage rates, in order to be consistent with current FHWA practice.

Proxy Measures for Transit Dependent People

Currently, demand forecasts are not developed separately by income level or automobile ownership levels. On the other hand, in setting out land use considerations associated with the proposals, AA/DEIS studies will often describe the projected demographic and socioeconomic composition of the corridor in question. This suggests that a suitable proxy measure might be the count of *existing households* (or of the *people* in those households) who

* live within, for example, one half mile of the proposed alignment of the new service, and

* indicate some appropriate measure of transportation disadvantage or transit dependency (for example, zero-car households, or households with income beneath the officially-designated poverty level).

There is a possibly perverse impact from this measure. It creates an additional incentive to plan rights of way through low income neighborhoods. Some urban transportation investment proposals, highway and transit, have been criticized in the past for "building rich people's facilities through poor people's bedrooms."

Recommended Measures of Mobility Impacts

As a *long-run proposition*, FTA is considering sponsoring or fostering some new analysis on improved demand forecasting for major transit investments, incorporating the following elements:

* Data collection and analysis by *market segments* based on (at least) the existing mode choice, the type of trip, and (possibly) the financial status of tripmakers;

* The forecasting of *induced trip* effects, based on detailed knowledge of the utility functions of the market segments; and

* Using the demand functions to compute the *net consumer surplus* impacts, as a measure of the mobility effects of the proposed investment.

* Improved methods for ascribing a *monetary value to travel time savings*.

Guidance for doing this in alternatives analyses would then be incorporated into the FTA's planning procedures manual.

In the *near term*, two proxy measures will be used to characterize the mobility impacts:

* The value of net travel time savings, given the projected trip table, ascribable to the proposed new start, compared with the TSM alternative, with the value of travel time savings, calculated using a standard percentage of the local average wage rate; and

* The number of zero-car households (or people in those households) located within ½ mile of boarding points for the proposed new facility, compared with the TSM Alternative

MEASURES OF "OPERATING EFFICIENCIES"

Under the new wording in Section 3(i), improved operating efficiencies are now an explicit new-start criterion. However, defining usable measures of operating efficiencies associated with transit capital investments requires answers to several critical questions, such as:

* What are operating efficiencies?
* How should operating efficiencies be measured?
* How should operating efficiencies be viewed when comparing alternative projects?

Review of these issues suggests that operating efficiencies should be measured in terms of the *change in operating costs per vehicle service hour (or mile), change in passengers per vehicle service hour (or mile),* and *change in passenger miles per vehicle service hour (or mile).*

What are Operating Efficiencies?

In general terms, "operating efficiencies" represent the extent to which the proposed transit investment would produce future resource savings for transit operators, relative to a well-defined reference case. But a more specific definition of operating efficiencies is necessary to develop quantitative measures that can be used to compare one project with another. One dimension on which greater specificity is needed concerns the *types* of resources considered in estimating efficiency gains.

The most comprehensive measure is to focus on total resources, irrespective of the type of resource or the use of that resource. In 1991, for example, the total operating costs of the transit industry were about $15.4 billion. If levels of service stayed constant, operating efficiencies would be achieved if the level of operating expenditures, expressed in real terms (corrected for inflation), declined.

Narrower definitions of operating efficiencies can be defined to focus on particular types of resources or particular kinds of transit activities. For example:

* Operating efficiencies could be defined for each of the major *types of resource* used to provide transit services. For example, Section 15 data breaks down the transit operating costs into seven categories of resource inputs and shows that labor accounts for about two-thirds of all operating costs.

* Alternatively, operating efficiencies could be measured by reviewing separately the costs of the different *types of activity* that transit operators undertake. Section 15 data breaks down transit industry operating costs into five categories of activity. Vehicle operations is the largest category, accounting for about 41 percent of all operating costs. General administration is the second largest category, about 10 percent of total operating costs.

Defining subcategories of operating efficiencies (either by type of resource or by type of activity) can be useful for several reasons. Aggregating all of the resources and activities together in one measure of operating efficiency can obscure particular efficiency achievements or problems. For example, a proposed project could generate overall operating efficiencies but involve inefficiencies

in the use of one particular resource or one particular activity needed to provide transit service. If the inefficiently-used resource or inefficiently-completed activity involved areas where there was a particular Federal interest in promoting efficiency, then knowledge of the detail could affect project rankings. In addition, reviewing subcategories of particular operating efficiencies could provide incentives for the applicants to focus more closely on operating efficiency in all levels of their project planning.

Breaking out the subcomponents of operating costs can also allow a city-specific correction for cost-of-living differences across different cities. For example, labor costs may vary significantly by city, but the cost of fuels and lubricants may differ less across cities. By tracking subcomponents of operating costs, projects could be compared across cities more easily. One project might be more expensive than another, but after correcting for labor efficiency, it might be determined that each project requires the same amount of physical input. In that case, the projects would be similar on a physical production basis, but different on an operating efficiency basis measured in dollars.

There are two arguments *against* the development of a range of detailed measures of operating efficiency:

* First, operating efficiencies associated with new transit investments will typically accrue over a period of time in the future. Applications for new-start funding may have great difficulty in developing projections of operating efficiencies for particular types of resources or particular types of activity. Consequently, the applicants may be able to produce estimates, but the estimates may not be particularly credible.

* Second, providing the detail on particular kinds of operating efficiencies should only be considered if it will materially affect the new-start project evaluation process. Different systems may achieve operating efficiencies in different ways, but ultimately the *overall* efficiency savings will be the key consideration for the evaluation process. If it is unlikely that a project with lower overall efficiency would be ranked less highly than one with more overall efficiency but less efficiency in particular areas, then seeking operating efficiency detail would create requirements that would never effectively be used.

In summary, defining operating efficiency involves a choice from among the following alternatives:

* Focus on total operating efficiencies;

* Focus on operating efficiencies broken down by type of resource, including
  - operating expenses for labor
  - operating expenses for materials and supplies
  - operating expenses for fuel and lubricants and other operating expenses;

* Focus on operating efficiencies broken down by type of activity, including
  - operating expenses for vehicles
  - operating expenses for maintenance
  - operating expenses for general administration

- operating expenses for purchased transportation; or

* Focus on operating efficiencies broken down both by type of resource and by type of activity.

How Should Operating Efficiencies Be Measured?

There are several issues involved in *measuring* operating efficiencies, whatever definition is chosen:

* **The scope of measurement**. First the physical, institutional, or geographic scope of the measurement should be determined. To be sure, measuring *systemwide* operating efficiencies brought about by a proposed investment represents one possible approach. However, it is possible that only parts of all the services provided by an existing transit system should be considered. For example, an extension or single new line added to an existing system would primarily affect operating costs on only part of that system, and operating efficiencies for the affected segment before and after the new start should be the primary focus of concern.

  Narrowing the geographic scope becomes increasingly important as the size of the transit system increases. In a system as large as that in New York, for example, any particular project, no matter how many efficiencies that it might induce, will appear to have a small efficiency impact on a systemwide basis. As such it might be incorrectly considered less worthy than a system which presents an application with lower overall savings but larger efficiency impacts on a percentage basis.

* **Measurement units**. It is possible to measure some subcategories of operating efficiencies with either dollars or physical units. For example, labor could be measured in person-hours instead of dollars. If the definition of operating efficiency involves more than one kind of resource input, however, dollars become the only practical measure.

* **Time horizon**. New starts are capital investments that operate over a period of many years. The difference in system operating costs needs to be specified for a particular time period. It is possible to cumulate the differences in operating costs over many years, and then discount the differences to get a net present value of differences over the time period. Alternatively, some particular year or years could be chosen, presumably to represent typical operating years in the life of the project.

* **Method of expression**. The total difference in operating costs could be considered, but that would not allow easy comparison across different projects, since project size will differ significantly from one area to another. To facilitate comparison of different-sized projects, operating costs per unit of output could be used. In "efficiency" measurements, it would be customary to express output in such supply-side units as revenue vehicle-hours, vehicle-miles, or place (seats and standee) -miles, but it would also be feasible to use the costs per passenger or per passenger-mile. Besides facilitating comparisons, such measures appeal to common sense. The operating cost per passenger can be compared to alternative transportation costs, such as taxi fares, and costs per

passenger-mile can be compared to standard automobile operating costs. Focusing on operating costs per passenger-mile makes it easier to compare projects that serve passengers making trips of different lengths.

Following a strict use of the terms *efficiency* and *effectiveness* would have us measure operating efficiency in, for example, operating costs per revenue vehicle-mile, and then define operating effectiveness as the ability of an agency to turn those vehicle-miles into passenger-miles. In this way, a transit property might be seen to be (for example) relatively efficient but also relatively ineffective.[8]

Because the various measures often portray differing pictures of performance, both Lee (1989b) and Fielding (1992) make a convincing case for using *multiple* indices to gauge transit performance. Not only does use of several different statistics give a clearer insight into the idiosyncrasies of specific situations, but it also permits (by using such techniques as factor analysis and cluster analysis) the definition of peer groups of comparable operating environments. Big agencies in large cities, perhaps with round-the-clock service and difficult operating environment, face different costs than those in medium- and small-sized cities, for example. Using peer groups of the sort identified by Fielding can be very useful in making comparisons among candidate projects, and not only when considering their operating efficiency implications. Such stratification of the new start proposals would be responsive to and fully consistent with the language of Section 3(i)(3)(B).

Fielding (1992) endorses the examination of five different indicators of operating efficiency and effectiveness, which are routinely used in "performance audits" carried out under California's Transportation Development Act. The five measures are:

* operating cost per passenger;
* operating cost per vehicle service-hour;
* passengers per vehicle service-hour;
* passengers per vehicle service-mile; and
* vehicle service-hours per employee.

The examination of prototypical alternatives analyses showed that the majority of them report data from which estimates of the change in operating and maintenance costs can be calculated. The basic ingredients of worthwhile operating efficiency/effectiveness measures are already being estimated in those studies, although there are variations in the extent to which the relevant data are included in the published reports. Calculations based on published data are complicated by the fact that financial statistics are usually presented on an annual basis, while ridership forecasts are often given only for the "average weekday." Such supply-side measures as vehicle-miles or vehicle-hours have obviously been calculated in many of these studies, but may not be reported explicitly; when they are reported, they may be given in either annual or average weekday terms.

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[8] See Chu, Fielding, and Lamar (1992), who identify Pittsburgh's PAT as an agency that improved efficiency significantly between 1980 and 1986, but for which regional demographic and economic trends meant that the agency had a significantly lower effectiveness than its peers. By contrast, Washington's Metrobus operations had the highest effectiveness score but the lowest efficiency score of their peer group.

Some uncertainties about the issue of geographical scope made it difficult to compute appropriate operating efficiency measures for some projects on the basis of the information presented in their alternatives analysis reports. Ideally, one should select as narrow a geographic scope as is appropriate to the new proposal, and examine the *incremental* operating costs and *incremental* measure of output associated with the project. There should be no difficulty in defining the alternatives analysis work scope to do that, but in the published reports it is sometimes difficult -- particularly for large transit systems -- to be certain that the two types of data are for the same geographical scope. In the worst case, working with the published data may only permit comparison of the change in *systemwide* operating costs with the ridership projected for the *new project.*

How Should Operating Efficiencies Be Used to Compare Alternative Projects?

Measures of operating efficiencies could be directly compared, to rank alternative projects on this criterion. However, some stratification of projects into broadly-defined peer groups makes sense, particularly because the projected impacts are often highly variable between projects. Also, the implicit precision in a measure (for example, the change in dollars spent per passenger-mile, measured to the penny) may be deceptive. There may be no real difference between efficiency gains per passenger-mile reported as (for instance) 3 cents and 2 cents, since on further investigation the full difference may be ascribable to variations in forecasting procedures.

Classifying projects by operating efficiency impact *categories* may help overcome the problem of erroneous precision. On the basis of the examination of the nine prototypical studies, possible categories appear to be:

* large net efficiency losses (20 percent or greater *increase* in the cost index);
* small net efficiency losses (less than 20 percent increase in the selected index); and
* net efficiency gains (an improvement -- that is, cost reduction -- in the index).

Alternatively, the dividing points in such a classification might be varied by peer group, reflecting the observed values from a larger sample of past alternatives analysis studies. The disadvantage of classification methods is that they will overstate the difference between two values that lie close to but on opposite sides of a boundary value.

Recommended Measures of Operating Efficiencies

On the basis of this review and discussion of the possibilities, FTA intends to require AA/DEIS studies to estimate at least two operating efficiency/effectiveness measures for each alternative. These would be the "change"[9] compared to the TSM alternative in

* operating cost per vehicle service-hour (or service-mile);
* passengers per vehicle service-hour (or service-mile); and
* passenger-miles per vehicle service-hour (or service-mile).

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[9] This change would be the differential between the alternative under consideration and the baseline alternative.

In the cast of large existing transit systems, these measures would consider only that part of the system that will be directly affected by the new investment, to the extent possible. They would estimate the *incremental* impacts on operating/maintenance costs and on the selected measure of output for the affected part of the system. *Systemwide* changes in operating efficiency would be used in all other cases, wherein the new start either

* represents a major component of the overall capacity, or
* is so integrated into the operations that isolating its own operating costs is not feasible or meaningful (because of significant economies or diseconomies of scale or scope).

MEASURES OF "ENVIRONMENTAL BENEFITS"

Identifying Environmental Benefits

The most commonly referenced environmental benefit in connection with major transit investment proposals is an improvement in urban air quality -- more specifically, reductions in mobile emissions from automobiles, including carbon monoxide, nitrogen oxides, and non-reactive hydrocarbons. Recently, increased interest in global warming has also focused attention on automobile emissions of carbon dioxide.

As well as air pollution, the revised FT Act explicitly mentions noise pollution as a factor that should be considered. Specifically, the Act instructs the Secretary of Transportation to "account for costs related to" air and noise pollution. Ordinarily, capital investments in transit systems should be expected to result in a *reduction* in air and noise pollution, and thus the "costs" mentioned in the Act must be understood as negative net costs, or positive benefits.

The Act also mentions energy consumption as an accountable cost, and tracking energy consumption might also fall under environmental benefits. Consumption of the petroleum and generation of electric power are directly related to concerns about air quality. In addition, there is an independent concern over energy consumption that focuses on energy *security* issues related to petroleum use. While not strictly an environmental issue, energy security does not fit neatly into the three other broad categories of concern to Congress -- mobility improvements, cost-effectiveness, or operating efficiencies -- so it might appropriately be considered under the environmental category.

The Act also specifically mentions the identification of future patterns of land use as a significant consideration. This is implicitly an environmental issue, and might be appropriately evaluated under the environmental heading.

Dealing with environmental benefits is a challenging issue and is analytically one of the most difficult dimensions of transit project evaluations. Clearly, one of the reasons more transit services are not privatized (and, indeed, a contributory factor why many of them were moved out of the private sector many years ago) is that public agencies can recognize, in a way that the private sector cannot, the social benefits from transit systems that spill over from the private use of those systems. Consequently, considering environmental benefits is an important and reasonable Federal responsibility.

The challenge arises because of the difficulty in developing non-controversial quantitative measures of environmental benefits that can be compared directly with the system's costs and benefits to users. Without these quantitative measures, environmental gains (or losses) cannot be traded off effectively with more direct system impacts. There are dangers of over- or underestimating value, and thus rating proposals as too high or too low in comparison with other contenders for the Section 3 "new start" funding.

Measuring and Valuing Environmental Benefits

Translating the enormous concern about environmental benefits into actionable decisionmaking means, first of all, forecasting the magnitude of the physical environmental impacts that are expected to occur. As discussed below, predicting these impacts can be quite difficult. Once the impacts are forecast, however, they must be valued, either implicitly or explicitly. The valuation process will primarily involve trading off environmental gains against construction costs, operating costs, and direct time savings to users.

Air Quality

Approaches for measuring or predicting air quality effects generally focus on changes in the emissions of specific pollutants. The US Environmental Protection Agency has developed emission factors for most mobile sources. These include factors for small particulate matter (PM-10), sulfur oxides (SO_2), various oxides of nitrogen (NO_x), hydrocarbons (HC), and carbon monoxide (CO). Hydrocarbons are further broken down into those that are reactive with ozone (thereby excluding methane) and those that are not. For this reason, the hydrocarbons may be more appropriately named nonmethane hydrocarbons (NMHC) and reactive organic compounds (ROC). Other researchers have developed similar emission factors for carbon dioxide (CO_2) and related greenhouse gas emissions.

These emission factors are quite useful, and make the task of forecasting air quality impacts a more manageable one. There are also officially-sanctioned models -- the most up-to-date is "Mobile-5" -- that can be used to predict the aggregate levels of emissions of various sorts, given the characteristics of the vehicle fleet and the geography and link volumes on the transportation network. The choice between such models in particular settings may still be a contentious issue, however. The state of the art in moving from *emissions* to actual *air quality* impacts, given the meteorological and other local conditions, is still fairly rudimentary. For this reason, attention usually focuses on emissions levels rather than on air quality *per se*, and is largely restricted to those cities where, for one or another pollutant, the air quality has not attained the standards contained in the Clean Air Act.

Generally, the task in evaluating transit investment proposals for nonattainment cities reduces to forecasting the levels of various emissions with and without the new start in place, and then valuing the predicted differences. Difficulties can arise if simplistic emission factors per mile are used in place of factors that measure "cold start," "hot soak," and "running" emissions separately. This is because different types of new transit projects may affect VMT reductions in different ways. Some systems may achieve VMT reductions by eliminating door-to-door auto trips. Others may achieve VMT reductions by encouraging park-and-ride behavior to divert only part of a trip by private vehicle. Today's cars rely on catalytic converters to control emissions, and these converters need some heat (provided by the engine exhaust) to reach peak efficiency. Consequently, the most polluting part of a trip is usually the first few miles of driving: emissions reduction is by no means proportional to VMT reduction.

Using average emission factors that do not recognize the significantly large emissions that result from the beginning portions of trips is the most common mistake in forecasting air quality impacts. Ignoring emissions that might result from the *construction* of the new transit project is

the next most common mistake. These emissions can result from increased congestion during construction and from the operation of construction vehicles; they are especially significant because they are produced first. Emission savings from operations far into the future might not offset near-term emissions because they need to be discounted to reflect their remoteness in time.

Finally, any incremental effects on the emissions from the power plants that will provide electricity to propel new transit systems need to be considered in a full accounting of the emissions implications. While energy produced from nuclear power or natural gas is relatively low in emissions, coal- or oil-fired capacity can generate some significant offsets in terms of emissions.

The examination of typical AA/DEIS reports shows that, given the environmental law requirements, all of them computed estimates of the impact on emissions of criteria pollutants for the *operational* phase of each alternative considered. On the other hand, there was little evidence that the *lifecycle* emissions implications of the alternatives had been considered adequately: system construction, fuel delivery, and power generation effects were frequently ignored or given inadequate coverage. Greenhouse gas emissions effects were also largely ignored.

Once emission impacts are forecast, the next step would be to value them. To demonstrate effectively the value of reduced emissions, one could point to:

* expenditures to mitigate the effects of air quality degradation that could be avoided if the proposed transit investment effectively reduced emissions; or

* demonstrated willingness-to-pay for air quality improvements by the citizens of the metropolitan area; or

* improvements in property value that might result from cleaner air.

One might expect the same improvements in air quality to be valued differently in different cities.[10] For example, the Los Angeles metropolitan area has some of the most serious air quality problems in the country. Emissions reductions there will have more value than reductions in metropolitan areas that are closer to attainment of the ambient air quality standards.

Absent standard values of the benefits from emission reductions, avoided cost is an inferior, but potentially useful approach. The avoided cost approach which is generally only applicable to nonattainment and maintenance areas, uses standard unit costs of pursuing alternative means of achieving emission reductions as a proxy for the benefits of such emission reductions.

In non-attainment areas, policies completely devoted to air quality improvements are being designed and implemented, and most have cost-effectiveness numbers attached to the strategies. These cost-effectiveness measures indicate the amounts that specific metropolitan areas are contemplating spending to improve air quality. These measures, combined with projected reduction measures from the transit proposal, can be used to develop values for the incremental air quality improvements related to the transit investment.

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[10] This argument is not true for greenhouse gas emissions, which are perceived, irrespective of location, to contribute to a worldwide problem.

Environmental Protection Agency (EPA) analyses of proposed changes in air quality regulations have used the avoided cost approach. To determine appropriate values for given pollutants, EPA looked at the avoided cost of pollution control that would be incurred if the pollution had to be reduced by other means. In the EPA methodology, the value of a ton of pollution control equals the avoided cost to society of controlling that pollution through existing means. The method is designed to allow EPA to compare proposed rules and other actions on a cost-effectiveness basis to existing rules and practices already in place. The approach ensures that high cost alternatives are not adopted until lower cost options are exhausted.

Examples of the values which result from the EPA methodology are recent analyses of Clean Air Act rules. Based on earlier rulemakings, EPA developed values for major precursors of tropospheric ozone (smog). The two major precursors are NO_x and Volatile Organic Compounds (VOC). EPA has observed the dollar cost per ton of mandated control strategies for NO_x and VOC. The cost of recent NO_x is $3,000 to $5,000 per ton. Similarly, the cost of recent VOC controls has been observed as $5,000 to $10,000 per ton. These are national averages, based on the costs of nationwide rules, affecting pollution sources in many different regions. Rules that focus on specific parts of the country (e.g., severe and extreme nonattainment areas, Southern California, etc.) show somewhat higher average dollar costs per ton.

Pending further analysis by EPA and the Department of Transportation, FTA intents to use the EPA avoided costs per ton as an interim proxy for the benefits of emission reductions in the relevant nonattainment/maintenance areas. These standard avoided costs per ton are nationwide averages and, therefore, do not reflect the fact that the cost of achieving emission reductions by alternative means varies depending on project location. If the environmental impacts of a proposed major transit investment are significant, additional analysis to develop an avoided cost estimate relevant to that specific nonattainment/maintenance area would be appropriate. FTA is interested in receiving comment on the appropriateness of the method used to calculate these values as well as its application for this purpose.

Noise Levels

Conceptually, the issue of measuring and valuing noise pollution reductions is very similar to the issue of measuring and valuing air pollution reductions. However, the empirical evidence suggests that achieving significant noise reductions and capturing the value of those reductions would result in only small gains.[11] To satisfy the legislative intent, a measure of effectiveness could be established and tracked. For example, the measure might be the projected change in person-hours of exposure to one decibel of noise levels of a specified frequency.

Energy Consumption and Energy Security

Energy *consumption* is of concern to the extent that the prices of the various different forms of energy might not fully reflect the long-run scarcity value of non-renewable forms. Since the generation of greenhouse gases is also closely linked with the form of energy used, it would be valuable from both viewpoints to project the year-by-year implications for the *amounts* of

[11] This generalization is supported by the examination of nine prototypical AA/DEIS study reports. While noise issues are addressed, the finding is typically that the transit investment will have either a minimal impact on noise levels, or else *increase* the level to an extent that merits mitigation.

different *types* of fuels, and with appropriate discounting to reduce these figures to net present value (and perhaps levelized) terms.

Reducing petroleum use is thought to increase energy *security* by reducing exposure to the expensive supply disruptions that might arise from conflicts or disputes in the Middle East. Here the measure to use is straightforward -- the barrels of petroleum saved as a result of the proposed transit project. However, as with the case of noise pollution, the value of these reductions is likely to be small. For example, there are analyses in the economics literature that place the value of energy security benefits at $4 to $5 per barrel of oil. Even in the most favorable case where each new transit rider formerly drove alone and switched to a transit mode that uses no petroleum, the benefits per new ride might still be small. For example, a 10-mile trip made in a 27.5 mpg car uses about one-third of a gallon of gasoline. Saving this gasoline results in a security gain of about 4 cents per trip if the $5 per barrel estimate of the value of energy security is correct. If the new start transit trip requires an auto access leg, which is often the case, the savings will be even smaller.

Four cents per trip is a small savings, and even that amount is probably overstated. While increasing energy security has value, some analysts are reluctant to link reduced petroleum use with increased security. They point out that cutting back on consumption, if significant, works to reduce the world price for petroleum. A reduced world price would mean that the marginal producers of petroleum are eliminated from the market. Consequently, the low-cost producers of oil in the Middle East would have a larger market share, and the world would be more reliant on the Middle East crude after the conservation measures are put in place.

The examination of prototypical AA/DEIS studies showed that the energy use of a project is usually addressed through forecasting the net urban expenditures on transportation energy, including project construction, operations and maintenance, and reduced automobile use. Developing year-by-year projections for the consumption of different types of fuels probably would not place an undue burden on the alternatives analysis process.

Recommended Measures of Environmental Benefits

Forecasted measures of the impact of transit proposals on the environment are proposed to be addressed as summarized in Table A1. For the most part, interpreting these measures is unambiguous, though petroleum conservation increases are not unanimously regarded as an automatic signal of gains in social welfare. FTA intends to focus its assessment on the results of estimates of these measures of effectiveness in terms of whether the new systems are likely to aggravate or ameliorate environmental conditions. This determination would be useful in distinguishing between systems that are otherwise equal in impact, but which differ in that one system improves environmental conditions and the other degrades them.

As with previous discussions of the timing of costs and benefits, the measures summarized in Table A1 would be projected over time, with the time period and the forecasts covering the construction years of the new transit system as well as its subsequent operation up to and beyond full build-out status. The net impacts projected for each year would be discounted, and the resulting net present value for the index would be levelized to characterize an "average year."

Looking at certain design year figures alone is wrong; it masks all of the construction effects that may have less favorable environmental implications for the proposed investment.

Table A1. Measures of Environmental Effectiveness

Environmental Factor	Effectiveness Measure	Direction of Effectiveness
Criteria pollutants	Dollar value of net pounds or tons of particular pollutants reduced per year, based on EPA valuation of unit reductions	Reduced emissions are better in areas that are not in attainment of Clean Air Act standards.
Greenhouse gas emissions	Dollar value of net pounds or tons of particular greenhouse gas emissions reduced per year, based on standard unit values	Reduced emissions are better.
Energy security	Barrels of petroleum saved per year	Reduced consumption of petroleum may or may not lead to increased security.
Energy consumption	Change in the consumption of fuels of different types	Reduced consumption of nonrenewable sources may be preferable.

MEASURES OF "TRANSIT SUPPORTIVE EXISTING LAND USE POLICIES AND FUTURE PATTERNS"

Identifying Land Use Benefits

Many proponents of new major transit projects argue that the new systems will result in more efficient land use patterns. They suggest that by encouraging more dense development patterns, particularly in the neighborhood of stations, the possibility increases for reduced tripmaking and more multipurpose trips, and for more efficient provision of public services such as sewer, water, and other utilities. Concentrated land use patterns could lead to more interpersonal contacts, increased networking, and more community interaction.

A quantitative effectiveness measure that would indicate the projected density increase (persons or jobs per square mile) as a result of the new start could be revealing. However, there are good reasons to be suspicious of such a measure, and very cautious in interpreting it:

* First, the linkages between transit systems and development densities are very difficult to identify in quantifiable terms. Some argue, for example, that while new transit facilities can increase commercial densities, they may actually reduce residential densities by providing options for commuters to live farther away from their jobs. For example, an extension to a radial system that serves the downtown core might result in some individuals moving farther away from their downtown jobs to take advantage of the new travel service. As a result, the local service jobs that follow population patterns may migrate farther out as well.

* Second, there are usually numerous disadvantages of more dense land use patterns that offset, either partially or totally, the advantages. For example, more dense development patterns increase exposure to certain kinds of air pollutants and reduce the value that many residents derive from suburban life styles and open space.

None of the AA/DEIS studies that were examined had projected employment or residential densities. Rather, the documents typically assessed the potential for future development in the corridor under study, and the ways in which the proposed transit investment could influence that development, and *vice versa*.

Given the complexity of projecting and valuing land use impacts, FTA intends to focus its appraisal not on land use *outcomes* but on land use *inputs* -- that is to say, on the set of local policies and processes in place (or proposed) to achieve the locally-specified land use goals, and on the extent to which the proposed transit investment might credibly be expected to reinforce or weaken those efforts. Such an appraisal will be made independently of the other performance measures and is described below. This approach will have the effect of rewarding local areas that make commitments to establishing more transit friendly land use patterns.

Identifying Supportive Land Use Policies and Patterns

The most important aspect in assuring that transit projects are supportive of appropriate local land use patterns, and in assuring that transit projects are supported by appropriate local land use

policies, is the market. No matter how good a desired development pattern looks at the planning stage, it must be translated into development in ways that make for places where people want to live, work, shop, and play. Transit proposals frequently face the conflict between an "ideal" urban form to support transit service and the continuation of low density, auto-dominant development patterns. The opportunities to share future land use patterns will be greater in those areas that are growing more rapidly. Thus, one goal of the land use criteria is an assessment of the receptiveness of the local land use market to transit-supportive land use patterns.

Also important is the type of land use which is proposed. Transit works best when it links higher density residential communities to large (minimum of 65,000 jobs), relatively dense mixed use nodes (i.e., the Central Business District). This said, local factors can adjust upward or downward how dense these areas must be and how large they must be. Equally important is the physical conditions at transit stations. Mixed land uses, which allow workers and residents to complete errands without automobiles, well-designed, pedestrian-oriented facilities, and other transit sensitive site planning can be just as important as the amount and density of development in making transit work.

Most major transit investments have a direct impact on several political jurisdictions, and their success is depended on the land use and economic development decisions make by general purpose local governments both inside and outside the transit corridor. Therefore, regional cooperation and local support is necessary. Regional cooperation is often difficult, and it helps if there is a track record of such cooperation.

The integration of the transit investment into the local governmental decisionmaking process is critical if these issues are to be adequately addressed. For a transit initiative to succeed, it must have strong support from local governments as an important public service they are willing to fund and as a function they are willing to support by reinforcing local planning, zoning, and infrastructure policies. At the same time, transit providers have a responsibility to become involved in regional and local land use planning decisions. Providing transit-sensitive land use design guidance to elected officials, planning staff, and developers is a vital contribution. Progress on establishing joint development programs is also important.

The criteria proposed here attempt to assess the degree to which the proposed transit project is likely to be supported by proper land use patterns and policies. To this end, the criteria address the current land use conditions, the future goals of the region, and the strategies in place to achieve these goals. Assessment of current conditions provides a baseline to gauge how far the community would have to go to meet its stated goals and to understand the amount of political and market support necessary to achieve the desired changes. The future goals stated by the community will be evaluated to assess how supportive they are likely to be for the proposed transit investment A community should have in mind a land use pattern which is consistent with the transit investment for the value of that investment to be maximized. Finally, and perhaps most importantly, the review of the strategies which the local governments plan will be used to assess the likelihood that the transit-supportive land use patterns and design will actually be achieved. A focus on specific programs, and their status as formally adopted policies is suggested.

In sum, the criteria address six areas of the land use planning process as it relates to the proposed transit investment:

- Patterns. What types of regional and local development patterns exist, at both the regional and project scale, what types are planned, and are they supportive of the proposed transit investment?
- Policies. What policies are in effect and/or proposed to achieve the future patterns described? Are the policies consistent with desirable future land use patterns?
- Process. How will the region and local governments develop and implement the policies described? Is the process likely to result in adoption of the necessary policies?
- Participants. Who will be involved in crafting and implementing these policies? Are all important potential actors fully involved?
- Practice. Have the policies been adopted and implemented? Or are they still in the development process?
- Performance. How effective have current policies been in achieving desirable land use patterns. Are there changes already in place? If not, what will be done to achieve such changes?

Land Use Criteria

It is intended that similar criteria be applied at each step of the project development process: the start of a major investment study, the start of preliminary engineering, and the start of final design. However, the criteria will be applied with greater intensity and with a greater expectation that policies and procedures will have been formally adopted the further the project is through the process. Projects will be rated "high," "medium," or "low" depending on the degree to which the local land use patterns, policies, process, participants, practice, and performance meet the standards laid out for each step in the process. This is similar to the approach FTA now takes for assessing local financial commitment, in which plans are reviewed for reasonableness at the earlier stages, but actual commitments are expected before a project proceeds to final design and construction.

Criteria at Initiation of A Major Investment Study

At this phase of the project development process, initial efforts to link the transit project with local land use planning must be begun. Land use and economic development must be integrated into the transportation planning process. To attain a "high" rating at this stage of the process, the following must be well underway.

Patterns. The transit service area (region and corridor under consideration) currently has sufficient population and employment to support high capacity transit. There is a regionally significant Central Business District (CBD) with a healthy mix of housing, office, and retail which will be served by the proposed project. There are existing public facilities and other major trip generating facilities which could be well served by a high capacity transit project. The region will develop in a compact pattern which is well suited to travel by transit. Significant growth will occur in the CBD and high capacity transit corridors.

Policies. There has been serious consideration of other regional actions to support transit, such as limits on parking, growth boundaries, zoning overlays, growth centers, plans to focus growth in the corridor, priority to transit investments over road investments, pedestrian considerations, and mixed use development. Transportation capital investment plans emphasize transit. The goal of encouraging transit use is reflected in regional transportation and land use plans.

Process. There is an understanding of the need for interagency cooperation in transportation issues, and evidence of past and current cooperation. There is a consensus on the desirable growth pattern among the key local governments, and the transit investment is seen as reinforcing that shared vision. Consideration of transit travel will be evident is all aspects of regional planning -- from urban form to site design. Commitments to consider developing major new public facilities in the transit corridor to maximize transit ridership have been made. Interlocal agreements are in place to fund and participate in the development of a corridor plan.

Participants. The local governments in the region have made adjustments to their land use and development plans to assure that the regional objectives will be realized. The region's governments and transit agency have considered commitments to encourage development in the corridor and to assure that corridor development it designed to encourage transit use. Interlocal agreements are in place to include the transit operator in both regional and local land use decisions. The region's economic development agency and the private sector/business community is involved in planning the transit project. The transit agency is consulted on key issues of regional growth management and development. The local governments and the transit provider have begun work to incorporate transit planning in all levels of land use planning in the region. The transit operator is working with local governments to include transit sensitive design features in local planning and zoning documents and specific development opportunities.

Criteria at the Initiation of Preliminary Engineering

In order to get a "high" rating from FTA as the project is ready to proceed into preliminary engineering, the corridor under consideration should have sufficient population and employment to support high capacity transit. Infill, redevelopment, and new development sites along the corridor should have been identified and planned with attention to their relationship to the transit project. The emphasis should be on transit supportive land uses, densities, and design. There should be adopted measures to direct growth to the corridor among the region's governments. Regional and local capital investment plans should include capital investments in the corridor to improve accessibility to the transit project. Specifically, in addition to those requirements noted above, the following should be in place for a project to receive a "high" rating.

Patterns. There is a regionally significant CBD with a healthy mix of housing, office and retail. There are existing or proposed public facilities and other high transit trip producers located along the corridor, which would be well served by the proposed project.

Policies. Local road standards have been reviewed to assure that they do not unnecessarily impede transit use. Policies are in place to local new major transit trip generating facilities in the transit corridor.

Process. A concept level corridor plan is in place with local and regional endorsement of the basic land use concepts involved. A commitment is in place to fund completion of a more detailed plan. The corridor plan includes a land use and public facilities plan, which would eventually be used to guide regional plan amendments and zoning revisions. The plan emphasizes encouraging development in the transit corridor by making transit oriented development easier, including expedited land use review and other incentives. Developers have been consulted to determine their assessment of the barriers to development. Short-range development targets, measures of effectiveness and reporting procedures, and supporting strategies to reach long term goals are in place. Concept level planning and zoning studies have been conducted in station areas. These plans include the business community and local economic development officials. Local governments have agreed to adopt the station area plans when they are completed.

Participants. Corridor and station area planning teams include representatives of the local land use agencies, as well as transit operator, business community and economic development officials.

Practice. Plans have been adopted at the regional and local level to direct growth to the corridor. This includes jurisdictions both within and outside the corridor. Local agencies have begun to consider how to leverage Federal investments by making improvements in the station areas, in the form of other locally provided infrastructure.

Performance. Local governments have received recent development proposals for high or medium density[12] housing in the corridor or CBD employment growth situated so that it would be served by the transit project. Agreements are in place to focus public infrastructure investment in the corridor. The transit agency is working with local governments to revised land use and zoning to encourage transit use. Transit service is integrated into community plans, designs and development. The transit agency is working with the appropriate economic development agencies to assure that corridor plans optimize corridor desirability and that potential projects and opportunities are considered in the transit planning process. Agreements are in place on the transit agency's role in local development review.

Criteria at the Initiation of Final Design

At this final step before a commitment is made to proceed with final design and construction, FTA will look for progress on implementing land use plans and on firm commitments to make the changes needed to successfully tie the transit project to supportive land uses. Because location will be nearly final at this stage, attention will be focused on the patterns and policies in station areas, and the degree to which site planning and other details have been made to be supportive of the transit investment.

To receive a "high rating", the station areas (1/2 mile radius around the stations) should contain moderate to high density housing[14] and employment densities. Special generators will be accessible to stations. Local governments responsible for land use in the station areas will have

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[12] For the purposes of these reviews, medium density housing is viewed as net site densities of at least 40 units per acre. This is a level of density at which land development patterns become more transit-supportive because of reduced parking ratios, or use of innovative site planning. Typical suburban garden apartments with 1.5 parking spaces per unit are equivalent to a site density of about 30 units per acre. The density levels which would be indicative of transit-supportive land use regulation and results would thus be in excess of this level.

made a concerted effort to encourage transit supportive land uses. They will provide the necessary infrastructure, enforce development guidelines which require the development patterns, densities, and mix of uses, and which provide appropriate incentives, to ensure a desirable transit environment. Establishment of Transportation Management Associations (TMA), improvement districts, tax abatement programs, or downtown business management districts, is encouraged in station areas to promote the areas and administer station area programs. Local governments in the corridor have formally adopted legally-binding transit zoning and other land use initiatives to encourage transit supportive land uses in the corridor. Local governments have adopted plan amendments to reflect the transit project. Specifically, to rate a project "high," FTA will expect the following.

Patterns. There is a regionally significant CBD with a healthy mix of housing, office, and retail. Stations are designed to serve special generators in the corridors. Station areas will be active pedestrian/transit oriented areas. A mixture of land uses will be concentrated around stations. Local government actions are in place to make station areas more "friendly" than the remainder of the region. Existing and proposed high density[14] residential development are/will be located within walking distance of stations.

Policies. Local governments have in place procedures to "fast track" and encourage developments in station areas.

Process. A detailed level corridor plan is in place with local and regional endorsement of the land use concepts involved. The corridor plan includes a land use and public facilities plan, which is being used to guide regional plan amendments and zoning revisions. The plan emphasizes encouraging development in the transit corridor by making transit oriented development easier, including expedited land use review and other incentives. Developers have been consulted to determine their assessment of the barriers to development. Short range development targets, measures of effectiveness and reporting procedures, and supporting strategies to reach long term goals are in place. Detailed planning and zoning studies have been conducted in station areas. These plans should include the business community and local economic development officials. Local governments have adopted the station area plans.

Participants. Corridor and station area planning teams include representatives of the local land use agencies, as well as transit operator, business community and economic development officials.

Practice. Station area plans are complete and results have been incorporated into local government planning and zoning documents. A corridor plan has been adopted. Local capital budgets (for public infrastructure) include the necessary projects in station areas. Funds are targeted to pedestrian improvements. Parking programs are in effect.

Performance. Progress has been made on changing land use plans and zoning to be more transit-supportive and to incorporate the adopted corridor plan. Progress has been made on economic development plans. The economic development agency has incorporated the transit project into its plans. Local governments have received recent development proposals for high density housing in station areas or for CBD employment growth in station areas. Local performance indicators of corridor market trends have been developed and regular progress reports are issued to indicate how well the market is responding to plans. Current and proposed

developments in the corridor and station areas meet identified performance goals. Policies for adjusting to market trends should be adopted.

Conclusion on Land Use Policies

FTA believes that this approach will best identify those proposed transit projects which have land use patterns and policies in place which are most supportive of the investment, by the time the final decision is made to proceed. To do so, the criteria are designed to assess the degree to which local governments have taken the measures needed to assure that the transit project is surrounded by supportive land use patterns and densities.

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